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PICATINNY ARSENAL

TECHNICAL DIVISION

FRAGMENTATION TEST

RECORD NO. 285

DATE 17 May 1954

SUBJECT: SHELL, HE, 105 MM, T178 (SERIES), METAL PARTS ASSEMBLY

EXCLUDED

FROM GENERAL CLASSIFICATION SCHEDULE IN ACCORDANCE WITH INFORMATION SECURITY PROGRAM REGULATION

DATED - JULY 1972

DOD 5000.1R & EXECUTIVE ORDER 11652
(EXECUTIVE ORDER 10501 AMENDED)

BY

Defense Documentation Center
Defense Supply Agency
Cameron Station
Alexandria, Virginia 22314

DEC 1972

PICATINNY ARSENAL
FRAGMENTATION TEST

Date: 17 May 1954
Test Record No. 285
Sheet: 1 of 3

REFERENCE	Project No. TA1-1546D, OO 471.381/12(C), ORDBB 471.14/950-130
DESCRIPTION OF AMMUNITION	Shell, HE, 105 mm, T178 (Series), Metal Parts Assembly T178E1 - Class 30 Cast Iron (QQ-I-652) T178E2 - Class 50 Cast Iron (QQ-I-652) T178E3 - Class A Malleable Iron (QQ-I-666) T178E4 - Cast Steel (MIL-S-20556) (Loaded with 70/30 Baratol, Cast TNT or Comp B)
DWG NO (METAL PARTS)	P-82283, rev 6/28/52
DWG NO (SHELL LDG)	None
QUANTITY IN LOT	2 in each lot
QUANTITY FRAGMENTED	24
METHOD OF FUNCTIONING	Fuze, M54, Mod, (modified for static firing) Dwg PX-97-287
FRAGMENTATION PROCEDURE	Shell fragmented at ambient temperature. Shell assembly equipped with electric ignition, placed in a pine box, with $\frac{1}{2}$" thick wall. The overall dimensions of the box were 10" x 10" x 20". The box was placed on end over 6' of sawdust in a 14' - 9" deep fragmentation tub, 15' - 5" in diameter at top and tapering to 13" diameter at bottom. Box covered with 5 feet of sawdust.
FRAGMENTATION RECOVERY AND CLASSIFICATION	Fragments were recovered from tub by sifting the sawdust on a mechanically-operated screen of No. 4 mesh (.170" opening, .08" wire diameter), using a magnetic separator. The fragments were classified by weighing and grouping according to the following weight zones:

Group 0 - 0 to ½ grain
1 - ½ to 2 grains
2 - 2 to 5 grains
3 - 5 to 10 grains
4 - 10 to 25 grains
5 - 25 to 50 grains
6 - 50 to 75 grains
7 - 75 to 150 grains
8 - 150 to 750 grains
9 - 750 to 2,500 grains
10 - Over 2,500 grains

MISCELLANEOUS DATA

The 105 mm, T178 (Series) Shell which were fragmented during the course of this test, were manufactured by the Lehigh Foundries of Easton, Pa. The subject shell were of two-piece silver-soldered base plug construction, as shown on Drawing P-82283, rev 6/28/52. The 105 mm, T178E1 Shell were cast from Class 30, cast iron (QQ-I-652). The 105 mm, T178E2 Shell were cast from Class 50, cast iron (QQ-I-652). The 105 mm, T178E3 Shell were cast from Class A Malleable Iron (QQ-I-666). The 105 mm, T178E4 Shell were cast from Cast Steel (MIL-S-20556).

DISCUSSION:

In analyzing the data, the following curves were employed:

Percent Average Cumulative Weight versus Group Number, for each pair of shell from each type of metal parts and each type of loading.

Twelve curves are inclosed, each of which gives a representation of the data shown on each of the inclosed Fragmentation Test Data Sheets. The "Percent Average Cumulative Weight" is based on the average weight of fragments (vs group no) of each pair of projectiles on the inclosed twelve data sheets.

By definition, the average cumulative weight of fragments equals the average weight of fragments in a group, plus the average weight of fragments of all preceding groups. The percent average cumulative weight of fragments is defined as the ratio of the average cumulative weight to the average weight of the empty shell.

According to information furnished in the 1st Ind, 3/2/54, Watertown Arsenal to PA, ORDBE-L 471.2/1824, ORDBB 471.14/10-122, subject: "Fragmentation Characteristics of Shell and Test Cylinders of Cast and Forged Steels (Project TA1-1546D)", shell fragments in the weight range of 10 - 50 grains constitute the most efficient casualty-producing size of fragment.

Using this Criterion for evaluating the relative efficiency of the various Shell Material - Explosive Filler combinations, the following table lists the combinations in descending order of lethality:

No.	Explosive Filler	Shell Metal Parts Material	Total wt of frags 10 to 50 grs (avg) X 100 / Weight of Empty Shell Metal Parts (avg)
1	Baratol	Class 50 Cast Iron	45.0%
2	Baratol	Class 30 Cast Iron	39.0%
3	TNT	Class 50 Cast Iron	34.0%
4	TNT	Class 30 Cast Iron	27.5%
5	Comp B	Class 50 Cast Iron	27.0%
6	Comp B	Class A Malleable Iron	27.0%
7	Comp B	Cast Steel	27.0%
8	TNT	Class A Malleable Iron	26.0%
9	Comp B	Class 30 Cast Iron	23.0%
10	TNT	Cast Steel	17.0%
11	Baratol	Class A Malleable Iron	17.0%
12	Baratol	Cast Steel	11.0%

A Bar Graph (Curve No. 13) shows, in descending order, the average total number of fragments occurring above 10 grains for each combination of shell metal parts - Explosive Filler fragmented.

The conclusion that Class 50 Cast Iron with Baratol filler is the most desirable is based entirely on the criterion established by Watertown Arsenal as given in correspondence referred to previously.

However, if the assumptions relative to the nature of terrain, effect of fragment velocities, and wound ballistics contained in various Ballistic Research Laboratories Reports, by T. Sterne, et al, are followed, the conclusions probably would be changed and the shell and explosive combinations giving fine degrees of fragmentation might be moved up into higher categories of preference. This involves decisions to be made only after consideration by higher echelons, such as Service Boards, ORO, and WSEG, and probably would require acquiring information on fragmentation velocity and distribution patterns which is presently not available.

JOHN D. ARMITAGE
Col, Ord Corps
Director, R & D Div

G. FLARTEY
George G. Flartey
P.S., P.S./B.D., for R+W.

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CATINNY ARSENAL FRAGMENTATION TEST

Projectile: 105mm, HE, T178E1, Cast from Class 30 Cast Iron (QQ-1-652)
Explosive Filler: TNT Cast
Type Fuze: M54 PD Modified for static firing Dwg. PX-97-287
Size of Box: 10" x 10" x 20", 1/2" Pine
Recovery Medium: Sawdust No. 4 Mesh Screen & Magnetic Separator

Test Record No: 6155
Sheet 1 of 12
Date: 30 Sept 52

Requested by Mr. P. Sadlon		PROJECTILE NO. 1		PROJECTILE NO. 2	
Wt. Empty Lbs.		17.09		17.45	
Wt. Loaded Lbs.		19.92		20.20	
Number and Weight of Recovered Fragments					
No. 0 Group Not	Through a 10 Mesh Screen (U. S. Std Sieve Series)				
0 to ½ Grs. Counted	Wt. Lbs.	2.93		2.31	
No. 1 Group	No.	15678		18239	
½ to 2 Grs.	Wt. Lbs.	2.21		2.51	
No. 2 Group	No.	5746		5703	
2 to 5 Grs.	Wt. Lbs.	2.59		2.65	
No. 3 Group	No.	2633		2704	
5 to 10 Grs.	Wt. Lbs.	2.62		2.80	
No. 4 Group	No.	1453		1470	
10 to 25 Grs.	Wt. Lbs.	3.08		3.27	
No. 5 Group	No.	312		332	
25 to 50 Grs.	Wt. Lbs.	1.50		1.58	
No. 6 Group	No.	71		57	
50 to 75 Grs.	Wt. Lbs.	.60		.49	
No. 7 Group	No.	27		33	
75 to 150 Grs.	Wt. Lbs.	.40		.48	
No. 8 Group	No.	8		5	
150 to 750 Grs.	Wt. Lbs.	.26		.12	
No. 9 Group	No.				
750 to 2500 Grs.	Wt. Lbs.				
No. 10 Group	No.				
2500 and Larger	Wt. Lbs.				
Total No.		25928		28543	
Total Wt. Lbs.		16.19		16.21	
% of Fragments Recovered		94.7		92.8	
Photo No.		M41485		None	

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CATINNY ARSENAL FRAGMENTATION TEST

Projectile: 105mm, HE, T178E2 Cast from Class 50 Cast Iron (QQ-1-652)
Test Record No: 6155
Explosive Filler: TNT Cast
Sheet 2 of 12
Type Fuze: M54 PD Modified for static firing Dwg. PX-97-287
Date:
Size of Box: 10" x 10" x 20", 1/2" Pine
Recovery Medium: Sawdust No. 4 Mesh Screen & Magnetic Separator

Requested by Mr. P. Sadlon

		PROJECTILE NO. 3	PROJECTILE NO. 4
Wt. Empty Lbs.		17.51	17.55
Wt. Loaded Lbs.		20.60	20.68
Number and Weight of Recovered Fragments — No. 0 Group 0 to ½ Grs.	Not Counted — Through a 10 Mesh Screen (U. S. Std Sieve Series) Wt. Lbs.	1.55	1.97
No. 1 Group ½ to 2 Grs.	No.	13104	11351
	Wt. Lbs.	1.89	1.62
No. 2 Group 2 to 5 Grs.	No.	5340	6413
	Wt. Lbs.	2.61	2.60
No. 3 Group 5 to 10 Grs.	No.	2541	3219
	Wt. Lbs.	2.55	3.02
No. 4 Group 10 to 25 Grs.	No.	1790	1802
	Wt. Lbs.	3.84	3.92
No. 5 Group 25 to 50 Grs.	No.	418	465
	Wt. Lbs.	2.01	2.25
No. 6 Group 50 to 75 Grs.	No.	105	90
	Wt. Lbs.	.91	.77
No. 7 Group 75 to 150 Grs.	No.	72	44
	Wt. Lbs.	1.02	.60
No. 8 Group 150 to 750 Grs.	No.	22	9
	Wt. Lbs.	.75	.24
No. 9 Group 750 to 2500 Grs.	No.		
	Wt. Lbs.		
No. 10 Group 2500 and Larger	No.		
	Wt. Lbs.		
Total No.		23392	23393
Total Wt. Lbs.		17.13	16.99
% of Fragments Recovered		97.8	96.8
Photo No.		M41487	None

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ICATINNY ARSENAL FRAGMENTATION TEST

Projectile: 105mm HE, T178E3, Cast from Class A Malleable (QQ-1-666)
Explosive Filler: TNT Cast
Type Fuze: M54 PD Modified for static firing
Size of Box: 10" x 10" x 20", 1/2" Pine Dwg. PA-97-287
Recovery Medium: Sawdust No. 4 Mesh Screen & Magnetic Separator

Test Record No: 6155
Sheet 3 of 12
Date:

Requested by Mr. P. Sadlon		PROJECTILE NO. 5	PROJECTILE NO. 6
Wt. Empty Lbs.		17.76	17.06
Wt. Loaded Lbs.		20.83	20.44
Number and Weight of Recovered Fragments			
No. 0 Group Not 0 to ⅛ Grs. Counted	Through a 10 Mesh Screen (U. S. Std Sieve Series) Wt. Lbs.	.26	.15
No. 1 Group ⅛ to 2 Grs.	No.	1914	2361
	Wt. Lbs.	.28	.33
No. 2 Group 2 to 5 Grs.	No.	866	1150
	Wt. Lbs.	.38	.53
No. 3 Group 5 to 10 Grs.	No.	730	641
	Wt. Lbs.	.69	.67
No. 4 Group 10 to 25 Grs.	No.	772	719
	Wt. Lbs.	1.70	1.67
No. 5 Group 25 to 50 Grs.	No.	589	526
	Wt. Lbs.	2.88	2.68
No. 6 Group 50 to 75 Grs.	No.	261	248
	Wt. Lbs.	2.20	2.19
No. 7 Group 75 to 150 Grs.	No.	285	281
	Wt. Lbs.	4.29	4.14
No. 8 Group 150 to 750 Grs.	No.	147	130
	Wt. Lbs.	4.86	4.56
No. 9 Group 750 to 2500 Grs.	No.		1
	Wt. Lbs.		.12
No. 10 Group 2500 and Larger	No.		
	Wt. Lbs.		
Total No.		5564	6057
Total Wt. Lbs.		17.54	17.04
% of Fragments Recovered		98.8	99.8
Photo No.		M41489	None

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ICATINNY ARSENAL FRAGMENTATION TEST

Projectile: 105mm, HE, T178E4 Cast from Cast Steel (Mil-S-20556)
Explosive Filler: TNT Cast
Type Fuze: M54 PD Modified for static firing Dwg. PX-97-287
Size of Box: 10" x 10" x 20", 1/2" Pine
Recovery Medium: Sawdust No. 4 Mesh Screen & Magnetic Separator

Test Record No: 6155
Sheet 4 of 12
Date:

Requested by Mr. P. Sadlon		PROJECTILE NO. 7		PROJECTILE NO. 8	
Wt. Empty Lbs.		18.40		18.15	
Wt. Loaded Lbs.		21.37		20.78	
Number and Weight of Recovered Fragments — No. 0 Group 0 to ½ Grs. Not Counted	Through a 10 Mesh Screen (U. S. Std Sieve Series)				
	Wt. Lbs.	.21		.21	
No. 1 Group ½ to 2 Grs.	No.	1921		2007	
	Wt. Lbs.	.28		.29	
No. 2 Group 2 to 5 Grs.	No.	929		1016	
	Wt. Lbs.	.42		.46	
No. 3 Group 5 to 10 Grs.	No.	538		542	
	Wt. Lbs.	.54		.56	
No. 4 Group 10 to 25 Grs.	No.	632		612	
	Wt. Lbs.	1.42		1.42	
No. 5 Group 25 to 50 Grs.	No.	333		344	
	Wt. Lbs.	1.72		1.72	
No. 6 Group 50 to 75 Grs.	No.	186		175	
	Wt. Lbs.	1.63		1.54	
No. 7 Group 75 to 150 Grs.	No.	260		279	
	Wt. Lbs.	4.00		4.18	
No. 8 Group 150 to 750 Grs.	No.	199		204	
	Wt. Lbs.	7.26		7.04	
No. 9 Group 750 to 2500 Grs.	No.	5		5	
	Wt. Lbs.	.65		.62	
No. 10 Group 2500 and Larger	No.				
	Wt. Lbs.				
Total No.		5003		5184	
Total Wt. Lbs.		18.13		18.04	
% of Fragments Recovered		98.5		99.4	
Photo No.		M-41491		None	CONFIDENTIAL

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CONFIDENTIAL PICATINNY ARSENAL FRAGMENTATION TEST

Projectile: 105mm, HE, T178E1, Cast from Class 30 Cast Iron (QQ-1-652)
Test Record No: 6155
Explosive Filler: Comp B
Sheet 5 of 12
Type Fuze: M54 PD Modified for static firing Dwg. PX-97-287
Date:
Size of Box: 10" x 10" x 20", 1/2" pine
Recovery Medium: Sawdust No. 4 Mesh Screen & Magnetic Separator

Requested by Mr. P. Sadlon		PROJECTILE NO. 9		PROJECTILE NO. 10	
Wt. Empty Lbs.		16.89		17.45	
Wt. Loaded Lbs.		19.87		20.70	
Number and Weight of Recovered Fragments		Through a 10 Mesh Screen (U. S. Std Sieve Series)			
No. 0 Group Not Counted					
0 to ½ Grs.	Wt. Lbs.	3.97		2.60	
No. 1 Group	No.	18372		18540	
½ to 2 Grs.	Wt. Lbs.	2.56		2.74	
No. 2 Group	No.	5636		6766	
2 to 5 Grs.	Wt. Lbs.	2.50		3.04	
No. 3 Group	No.	2129		2657	
5 to 10 Grs.	Wt. Lbs.	2.11		2.77	
No. 4 Group	No.	1090		1325	
10 to 25 Grs.	Wt. Lbs.	2.30		2.91	
No. 5 Group	No.	255		333	
25 to 50 Grs.	Wt. Lbs.	1.22		1.59	
No. 6 Group	No.	61		60	
50 to 75 Grs.	Wt. Lbs.	.53		.53	
No. 7 Group	No.	37		44	
75 to 150 Grs.	Wt. Lbs.	.51		.63	
No. 8 Group	No.	1		10	
150 to 750 Grs.	Wt. Lbs.	.02		.27	
No. 9 Group	No.				
750 to 2500 Grs.	Wt. Lbs.				
No. 10 Group	No.				
2500 and Larger	Wt. Lbs.				
Total No.		27581		29735	
Total Wt. Lbs.		15.72		17.08	
% of Fragments Recovered		93.1		97.9	
Photo No.		M-42034		None	

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PICATINNY ARSENAL FRAGMENTATION TEST

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Projectile: 105mm, HE, T178E2 Cast from Class 50 Cast Iron. (QQ-1-652)
Explosive Filler: Comp B
Type Fuze: M54 PD Modified for static firing Dwg. PX-97-287
Size of Box: 10" x 10" x 20", 1/2" Pine
Recovery Medium: Sawdust No. 4 Mesh Screen & Magnetic Separator

Test Record No: 6155
Sheet 6 of 12
Date:

Requested by Mr. P. Sadlon

		PROJECTILE NO. 11		PROJECTILE NO. 12	
Wt. Empty Lbs.		17.71		17.58	
Wt. Loaded Lbs.		21.02		20.56	
Number and Weight of Recovered Fragments					
No. 0 Group Not	Through a 10 Mesh Screen (U. S. Std Sieve Series)				
0 to ½ Grs. Counted	Wt. Lbs.	3.45		2.56	
No. 1 Group	No.	17872		22993	
½ to 2 Grs.	Wt. Lbs.	2.67		1.64	
No. 2 Group	No.	6535		6591	
2 to 5 Grs.	Wt. Lbs.	2.88		3.06	
No. 3 Group	No.	2760		2904	
5 to 10 Grs.	Wt. Lbs.	2.74		2.94	
No. 4 Group	No.	1491		1530	
10 to 25 Grs.	Wt. Lbs.	3.15		3.68	
No. 5 Group	No.	282		258	
25 to 50 Grs.	Wt. Lbs.	1.34		1.24	
No. 6 Group	No.	46		34	
50 to 75 Grs.	Wt. Lbs.	.39		.29	
No. 7 Group	No.	31		28	
75 to 150 Grs.	Wt. Lbs.	.46		.38	
No. 8 Group	No.	4		8	
150 to 750 Grs.	Wt. Lbs.	.10		.23	
No. 9 Group	No.				
750 to 2500 Grs.	Wt. Lbs.				
No. 10 Group	No.				
2500 and Larger	Wt. Lbs.				
Total No.		29021		34346	
Total Wt. Lbs.		17.18		16.02	
% of Fragments Recovered		97.0		91.1	
Photo No.		M42036		None	

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PICATINNY ARSENAL FRAGMENTATION TEST

Projectile: 105mm HE, T178E3 Cast from Class A Malleable (QQ-1-666)

Explosive Filler: Comp B

Type Fuze: M54 PD Modified for static firing Dwg. PX-97-287

Size of Box: 10" x 10" x 20", 1/2" Pine

Recovery Medium: Sawdust No. 4 Mesh Screen & Magnetic Separator

Test Record No: 6155

Sheet 7 of 12

Date:

Requested by Mr. P. Sadlon			PROJECTILE NO. 13		PROJECTILE NO. 14		
Wt. Empty Lbs.			18.25		17.40		
Wt. Loaded Lbs.			20.08		20.69		
Number and Weight of Recovered Fragments	No. 0 Group Not 0 to ½ Grs. Counted	Through a 10 Mesh Screen (U. S. Std Sieve Series) Wt. Lbs.	.81		.23		
	No. 1 Group ½ to 2 Grs.	No.	5403		2561		
		Wt. Lbs.	.80		.37		
	No. 2 Group 2 to 5 Grs.	No.	2495		1613		
		Wt. Lbs.	1.14		.67		
	No. 3 Group 5 to 10 Grs.	No.	1391		524		
		Wt. Lbs.	1.42		.53		
	No. 4 Group 10 to 25 Grs.	No.	1476		528		
		Wt. Lbs.	3.33		1.21		
	No. 5 Group 25 to 50 Grs.	No.	699		307		
		Wt. Lbs.	3.51		1.58		
	No. 6 Group 50 to 75 Grs.	No.	216		189		
		Wt. Lbs.	1.85		1.73		
	No. 7 Group 75 to 150 Grs.	No.	134		240		
		Wt. Lbs.	1.89		3.68		
	No. 8 Group 150 to 750 Grs.	No.	52		193		
		Wt. Lbs.	1.76		6.93		
	No. 9 Group 750 to 2500 Grs.	No.			1		
		Wt. Lbs.			.12		
	No. 10 Group 2500 and Larger	No.					
		Wt. Lbs.					
Total No.			11866		6156		
Total Wt. Lbs.			16.51		17.05		
% of Fragments Recovered			90.5		98		
Photo No.			M42038		None		

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PICATINNY ARSENAL FRAGMENTATION TEST

Projectile: 105mm HE, T178E4 Cast from Cast Steel (Mil-S-20556) Test Record No: 6155

Explosive Filler: Comp B Sheet 8 of 12

Type Fuze: M54 PD Modified for static firing Date:

Dwg. PX-97-287

Size of Box: 10" x 10" x 20", 1/2" Pine

Recovery Medium: Sawdust No. 4 Mesh Screen & Magnetic Separator

		PROJECTILE NO.			
Requested by Mr. P. Sadlon		15		16	
Wt. Empty Lbs.		17.97		17.94	
Wt. Loaded Lbs.		20.62		21.06	
Number and Weight of Recovered Fragments					
No. 0 Group Not	Through a 10 Mesh Screen (U. S. Std Sieve Series)				
0 to ½ Grs. Counted	Wt. Lbs.	.22		.28	
No. 1 Group	No.	3278		2127	
½ to 2 Grs.	Wt. Lbs.	.48		.32	
No. 2 Group	No.	1560		1111	
2 to 5 Grs.	Wt. Lbs.	.71		.54	
No. 3 Group	No.	802		568	
5 to 10 Grs.	Wt. Lbs.	.81		.60	
No. 4 Group	No.	1092		690	
10 to 25 Grs.	Wt. Lbs.	2.48		1.61	
No. 5 Group	No.	645		439	
25 to 50 Grs.	Wt. Lbs.	3.24		2.28	
No. 6 Group	No.	284		231	
50 to 75 Grs.	Wt. Lbs.	2.45		2.17	
No. 7 Group	No.	282		212	
75 to 150 Grs.	Wt. Lbs.	4.14		3.37	
No. 8 Group	No.	103		164	
150 to 750 Grs.	Wt. Lbs.	3.30		6.13	
No. 9 Group	No.	1		4	
750 to 2500 Grs.	Wt. Lbs.	.11		.52	
No. 10 Group	No.				
2500 and Larger	Wt. Lbs.				
Total No.		8047		5546	
Total Wt. Lbs.		17.94		17.82	
% of Fragments Recovered		99.8		99.3	
Photo No.		M42040		None	

Reviewed by L. D. Bercow
Chief, Proof Testing Unit

Approved by L. F. Page
Chief, Testing Section

Prepared by C. Smalinski

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PICATINNY ARSENAL FRAGMENTATION TEST

Projectile: 105mm, HE. T178E1, cast from Class 30 cast iron (QQ-I-652)
Explosive Filler: Baratol
Type Fuze: M54 PD. Modified for static firing, Dwg. PX-87-287
Size of Box: 10" x 10" x 20", 1/2" Pine
Recovery Medium: Sawdust, No. 4 Mesh Screen and Magnetic Separator
Requested by Mr. P. Sadlon

Test Record No: 6155
Sheet 9 **of** 12
Date: 15 June 1953

			PROJECTILE NO.				
			17	18			
Wt. Empty Lbs.			17.51	17.28			
Wt. Loaded Lbs.			22.02	22.10			
Number and Weight of Recovered Fragments	No. 0 Group	Through a	10 Mesh Screen (U. S. Std Sieve Series)				
	0 to ½ Grs.	Wt. Lbs.	2.28	1.07			
	No. 1 Group	No.	10600	10159			
	½ to 2 Grs.	Wt. Lbs.	1.56	1.33			
	No. 2 Group	No.	4938	4540			
	2 to 5 Grs.	Wt. Lbs.	2.25	2.02			
	No. 3 Group	No.	2486	2319			
	5 to 10 Grs.	Wt. Lbs.	2.52	2.37			
	No. 4 Group	No.	1693	2060			
	10 to 25 Grs.	Wt. Lbs.	3.66	4.60			
	No. 5 Group	No.	430	618			
	25 to 50 Grs.	Wt. Lbs.	2.08	2.95			
	No. 6 Group	No.	115	81			
	50 to 75 Grs.	Wt. Lbs.	1.00	.68			
	No. 7 Group	No.	67	55			
	75 to 150 Grs.	Wt. Lbs.	.96	.78			
	No. 8 Group	No.	19	17			
	150 to 750 Grs.	Wt. Lbs.	.52	.55			
	No. 9 Group	No.					
	750 to 2500 Grs.	Wt. Lbs.					
	No. 10 Group	No.					
	2500 and Larger	Wt. Lbs.					
Total No.			20348	19849			
Total Wt. Lbs.			16.83	16.35			
% of Fragments Recovered			96.1	94.6			
Photo No.			M-42865	M42866			CONFIDENTIAL

ARMY-P. A. DOVER, N. J.

CONFIDENTIAL PICATINNY ARSENAL FRAGMENTATION TEST

Projectile: 105mm, HE. T178E2, Cast from Class50 Cast Iron (QQ-I-652)

Explosive Filler: Baratol

Type Fuze: M54 PD Modified for static firing

Dwg. PX-97-287

Size of Box: 10" x 10" x 20", 1/2" Pine

Recovery Medium: Sawdust, No. 4 Mesh Screen & Magnetic Separator

Test Record No: 6155

Sheet 10 of 12

Date:

Requested by Mr. P. Sadlon

			PROJECTILE NO.				
			19	20			
Wt. Empty Lbs.			17.58	17.43			
Wt. Loaded Lbs.			22.41	22.41			
Number and Weight of Recovered Fragments	No. 0 Group	Through a	10 Mesh Screen (U.S. Std	Sieve Series)			
	0 to ½ Grs.	Wt. Lbs.	1.31	1.15			
	No. 1 Group	No.	9845	8202			
	½ to 2 Grs.	Wt. Lbs.	1.45	1.24			
	No. 2 Group	No.	3755	3324			
	2 to 5 Grs.	Wt. Lbs.	1.80	1.50			
	No. 3 Group	No.	1977	2215			
	5 to 10 Grs.	Wt. Lbs.	2.03	2.20			
	No. 4 Group	No.	1912	1871			
	10 to 25 Grs.	Wt. Lbs.	4.37	4.26			
	No. 5 Group	No.	740	806			
	25 to 50 Grs.	Wt. Lbs.	3.65	3.42			
	No. 6 Group	No.	152	175			
	50 to 75 Grs.	Wt. Lbs.	1.31	1.49			
	No. 7 Group	No.	58	99			
	75 to 150 Grs.	Wt. Lbs.	.87	1.34			
	No. 8 Group	No.	18	20			
	150 to 750 Grs.	Wt. Lbs.	.73	.81			
	No. 9 Group	No.					
	750 to 2500 Grs.	Wt. Lbs.					
	No. 10 Group	No.					
	2500 and Larger	Wt. Lbs.					
Total No.			18457	16712			
Total Wt. Lbs.			17.52	17.41			
% of Fragments Recovered			99.6	~~99.8~~ 99.9			
Photo No.			M-42867	M-42868			CONFIDENTIAL

ARMY-P. A. DOVER, N. J.

CONFIDENTIAL

PICATINNY ARSENAL FRAGMENTATION TEST

Projectile: 105mm, HE, T178E3, Cast from Class A Malleable (QQ-I-666)
Explosive Filler: Baratol
Type Fuze: M54 PD Modified for static firing Dwg. PX-97-287
Size of Box: 10" x 10" x 20", 1/2" Pine
Recovery Medium: Sawdust, No. 4 Mesh Screen & Magnetic Separator

Test Record No: C155
Sheet 11 of 12
Date: 15 June 53

Requested by Mr. P. Sadlon

		PROJECTILE NO. 21	PROJECTILE NO. 22			
Wt. Empty Lbs.		17.52	17.56			
Wt. Loaded Lbs.		22.32	22.31			
Number and Weight of Recovered Fragments — No. 0 Group	Through a	10 Mesh Screen (U. S. Std Sieve Series)				
0 to ½ Grs.	Wt. Lbs.	.43	.28			
No. 1 Group	No.	2166	1233			
½ to 2 Grs.	Wt. Lbs.	.32	.17			
No. 2 Group	No.	1226	639			
2 to 5 Grs.	Wt. Lbs.	.51	.28			
No. 3 Group	No.	733	159			
5 to 10 Grs.	Wt. Lbs.	.35	.13			
No. 4 Group	No.	737	426			
10 to 25 Grs.	Wt. Lbs.	1.62	1.01			
No. 5 Group	No.	425	251			
25 to 50 Grs.	Wt. Lbs.	2.05	1.26			
No. 6 Group	No.	228	178			
50 to 75 Grs.	Wt. Lbs.	2.02	1.53			
No. 7 Group	No.	288	231			
75 to 150 Grs.	Wt. Lbs.	4.27	3.48			
No. 8 Group	No.	141	123			
150 to 750 Grs.	Wt. Lbs.	5.10	8.64			
No. 9 Group	No.	4	5			
750 to 2500 Grs.	Wt. Lbs.	.52	.70			
No. 10 Group	No.					
2500 and Larger	Wt. Lbs.					
Total No.		5948	3243			
Total Wt. Lbs.		17.49	17.51			
% of Fragments Recovered		99.8	99.7			
Photo No.		M-42869	M-42870			CONFIDENTIAL

ARMY-P. A. DOVER, N. J. 6-3-53 1 000

CONFIDENTIAL

CATINNY ARSENAL FRAGMI TATION TEST

Projectile: 105mm, HE, T178E4, Cast from Cast Steel (Mil-S-20556) Test Record No: 6155

Explosive Filler: Baratol Sheet 12 of 12

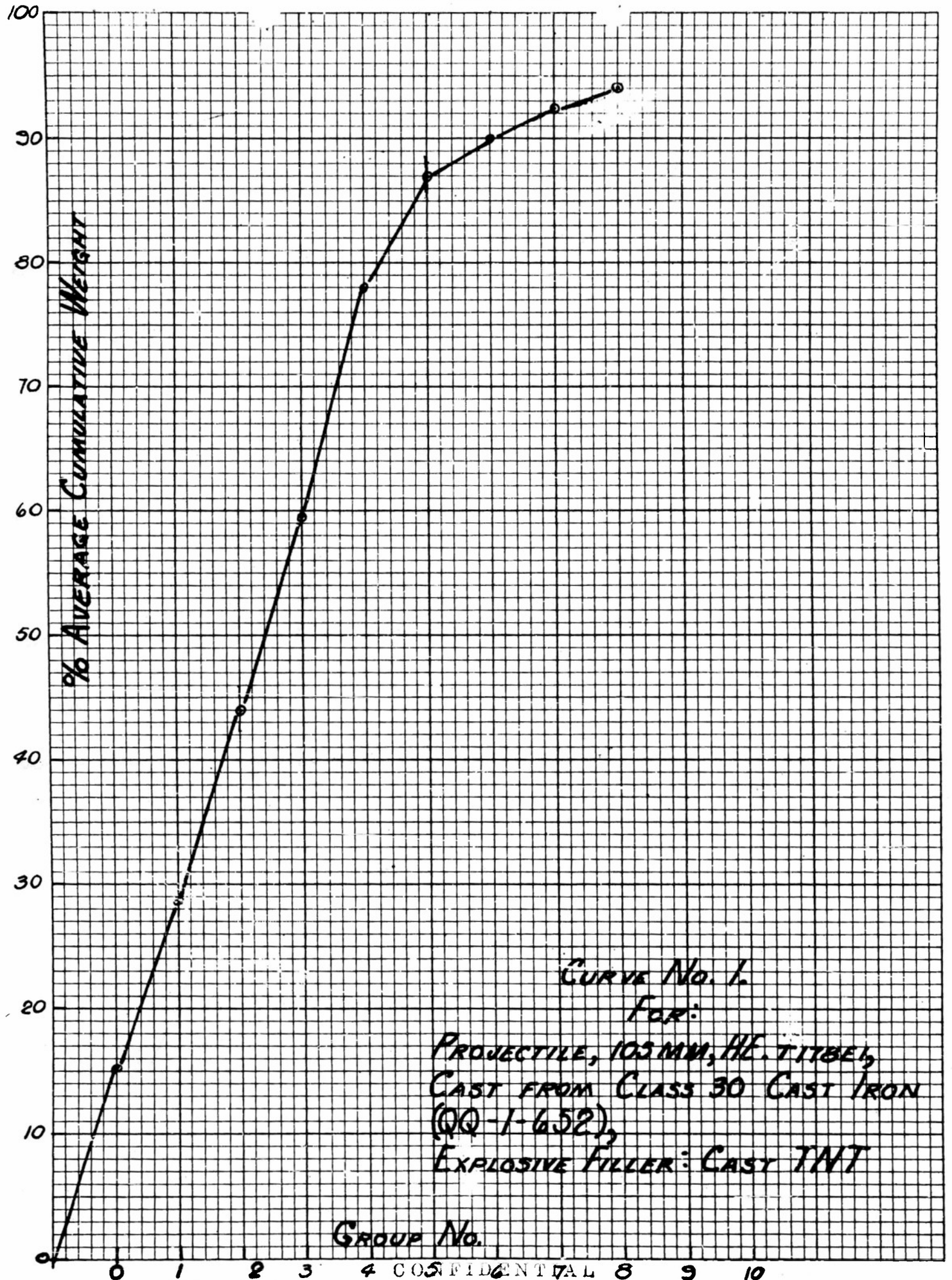
Type Fuze: M54 PD Modified for static firing Date:

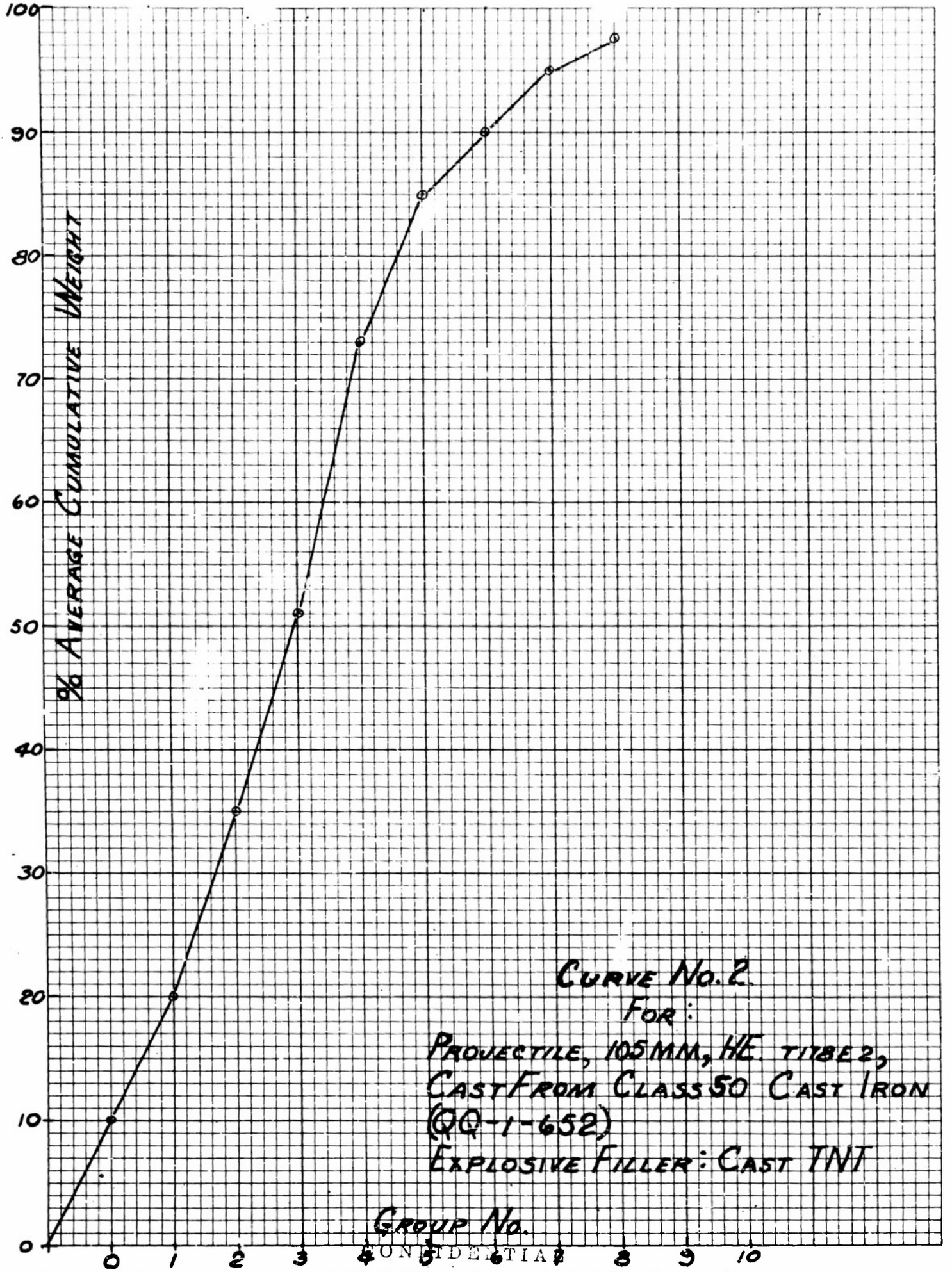
Size of Box: 10" x 10" x 20" Pine Dwg. PX-97-287

Recovery Medium: Sawdust, No. 4 Mesh Screen & Magnetic Separator

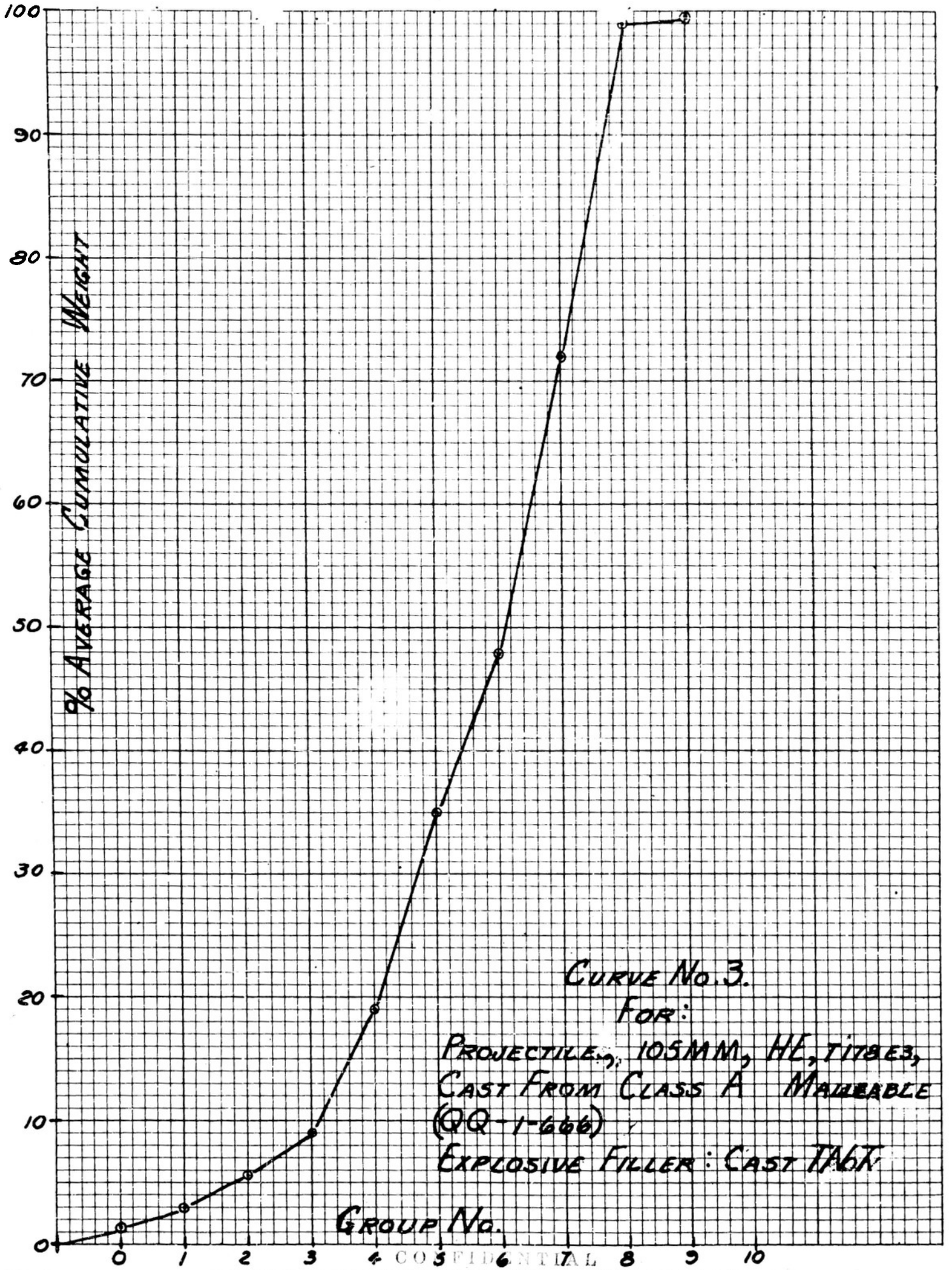
Requested by Mr. P. Sadlon

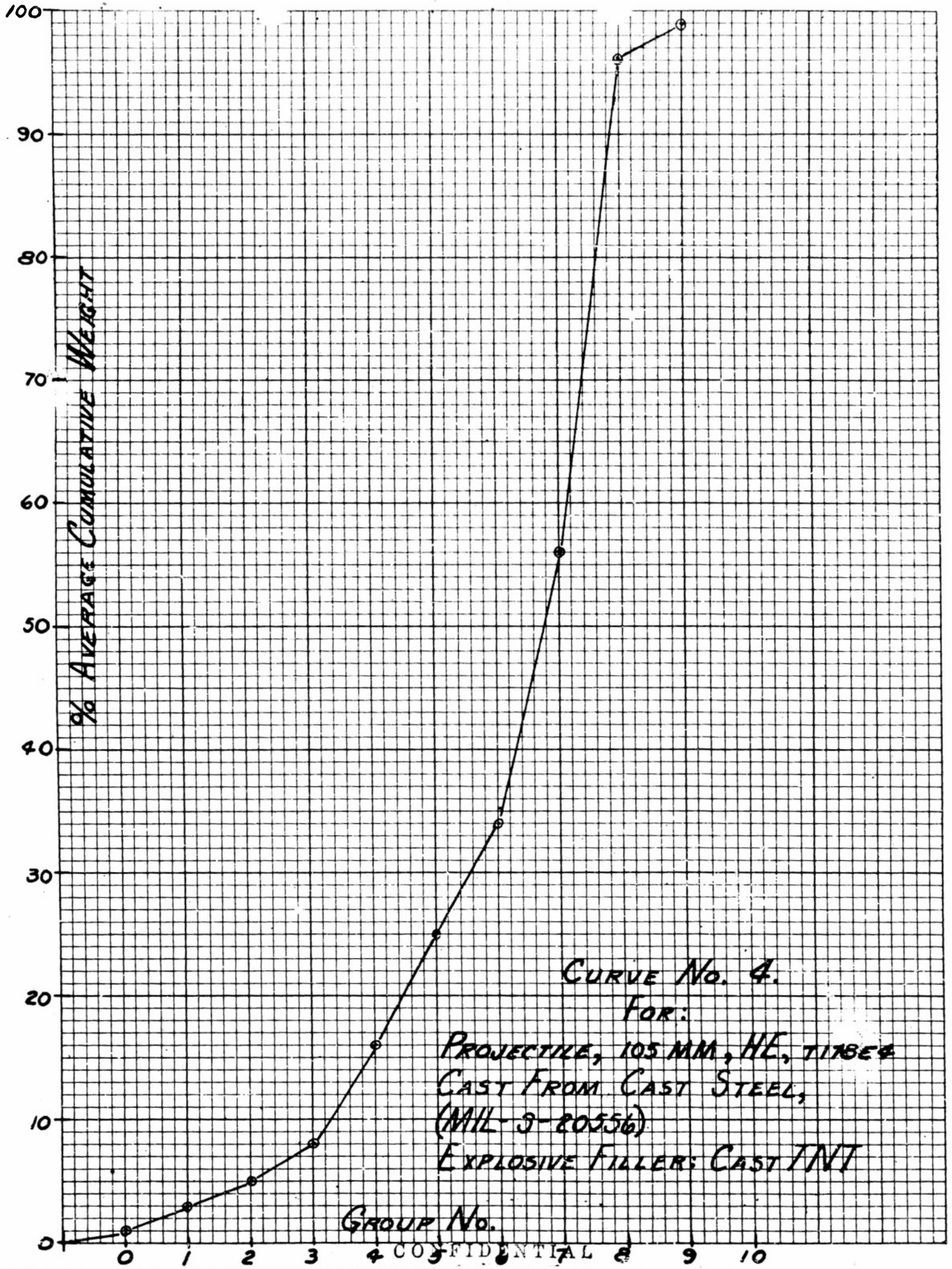
			PROJECTILE NO.				
			23	24			
Wt. Empty Lbs.			18.46	18.11			
Wt. Loaded Lbs.			23.03	22.70			
Number and Weight of Recovered Fragments	No. 0 Group	Through a	10 Mesh Screen (U. S. Std	Sieve Series)			
	0 to ½ Grs.	Wt. Lbs.	.18	.19			
	No. 1 Group	No.	1151	1217			
	½ to 2 Grs.	Wt. Lbs.	.15	.18			
	No. 2 Group	No.	551	624			
	2 to 5 Grs.	Wt. Lbs.	.25	.29			
	No. 3 Group	No.	365	384			
	5 to 10 Grs.	Wt. Lbs.	.37	.40			
	No. 4 Group	No.	445	399			
	10 to 25 Grs.	Wt. Lbs.	1.02	.92			
	No. 5 Group	No.	221	214			
	25 to 50 Grs.	Wt. Lbs.	1.10	1.05			
	No. 6 Group	No.	105	108			
	50 to 75 Grs.	Wt. Lbs.	.90	.96			
	No. 7 Group	No.	158	132			
	75 to 150 Grs.	Wt. Lbs.	2.46	2.07			
	No. 8 Group	No.	219	226			
	150 to 750 Grs.	Wt. Lbs.	10.01	10.17			
	No. 9 Group	No.	16	13			
	750 to 2500 Grs.	Wt. Lbs.	2.00	1.86			
	No. 10 Group	No.					
	2500 and Larger	Wt. Lbs.					
Total No.			3231	3317			
Total Wt. Lbs.			18.44	18.09			
% of Fragments Recovered			~~99.8~~ 99.9	~~99.8~~ 99.9			
Photo No.			M-42871	M-42872			CONFIDENTIAL

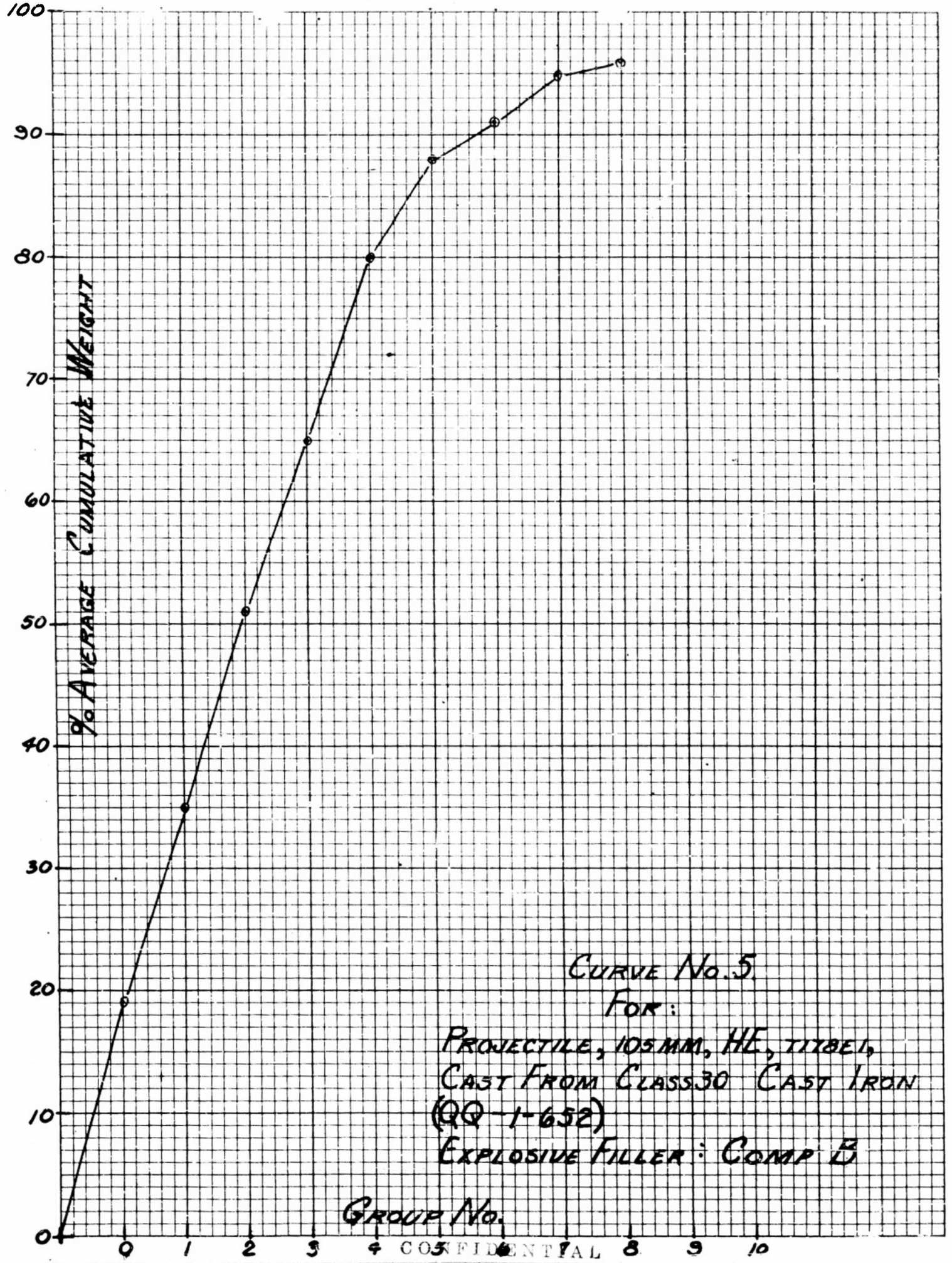

% Average Cumulative Weight
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Group No.
Curve No. 1.
For:
Projectile, 105 MM, HE. T1TBE1,
Cast from Class 30 Cast Iron
(QQ-I-652),
Explosive Filler: Cast TNT



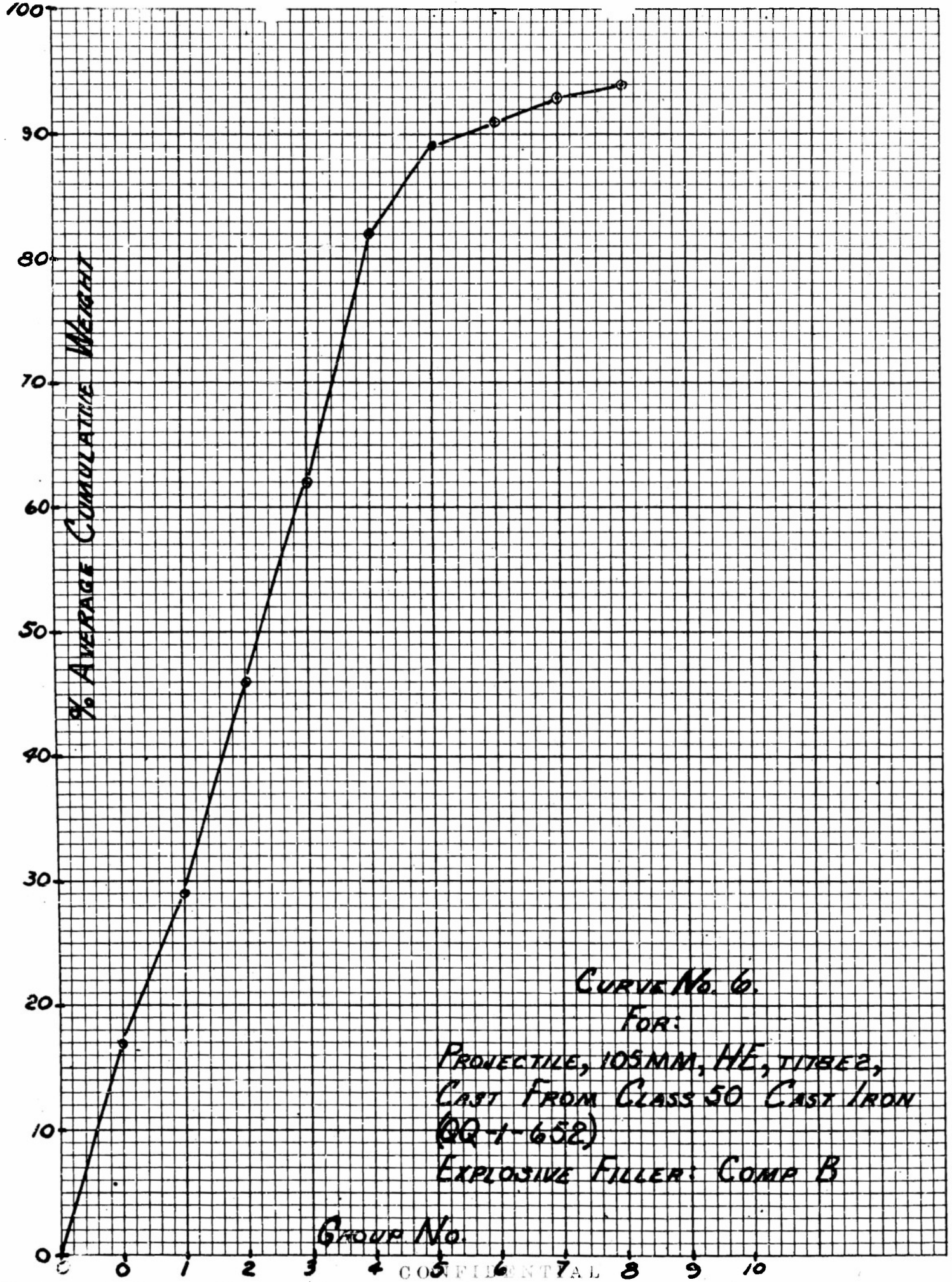
Curve No. 2.
For:
Projectile, 105MM, HE. Tube 2,
Cast From Class 50 Cast Iron
(QQ-I-652)
Explosive Filler: Cast TNT


% Average Cumulative Weight
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Group No.
Curve No. 3.
For:
Projectiles, 105MM, HE, T17E3,
Cast From Class A Malleable
(QQ-I-666)
Explosive Filler: Cast TNT

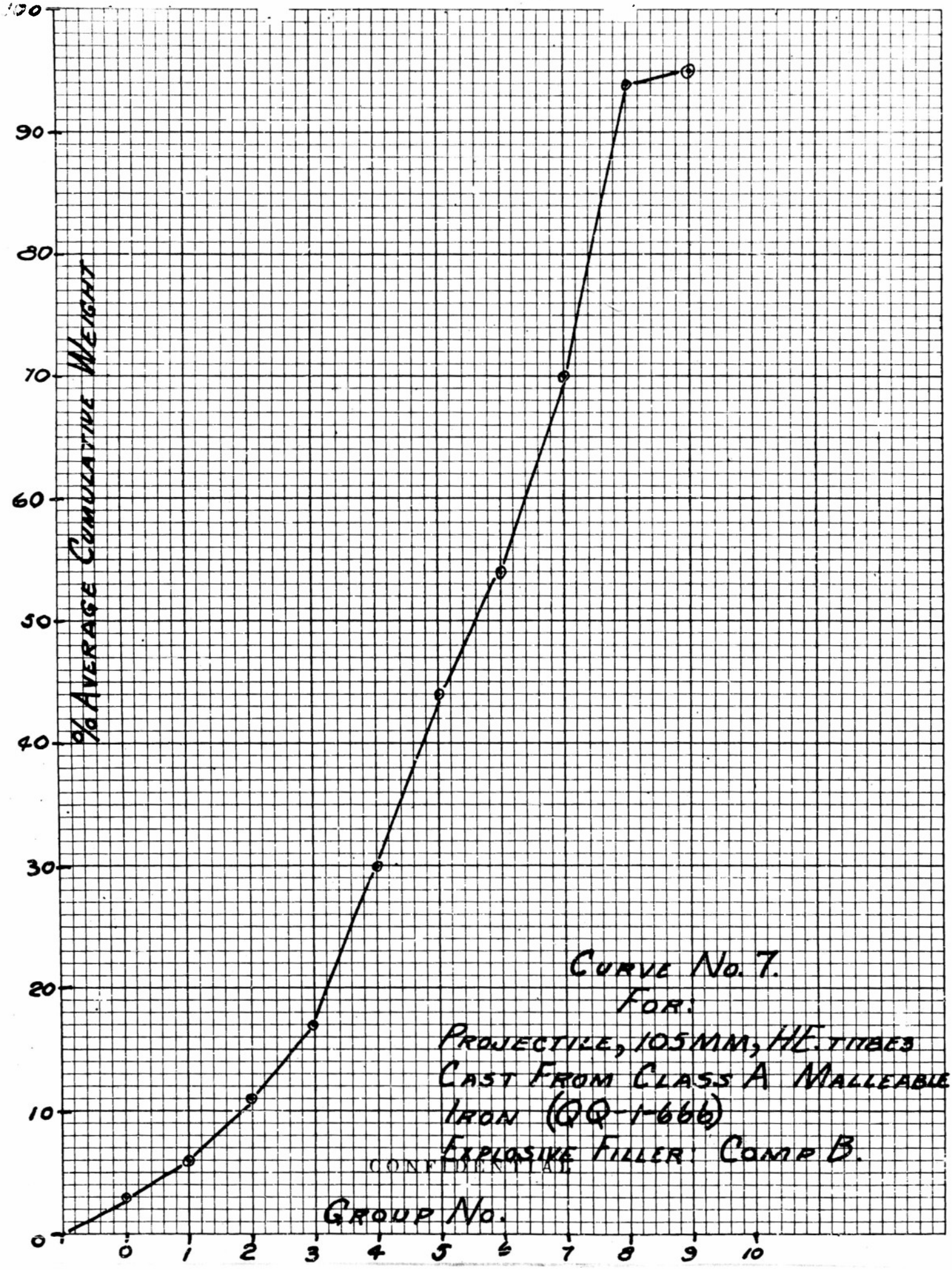

% Average Cumulative Weight
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Group No.
Curve No. 4.
For:
Projectile, 105 MM, HE, Tiber
Cast From Cast Steel,
(MIL-S-20556)
Explosive Filler: Cast TNT



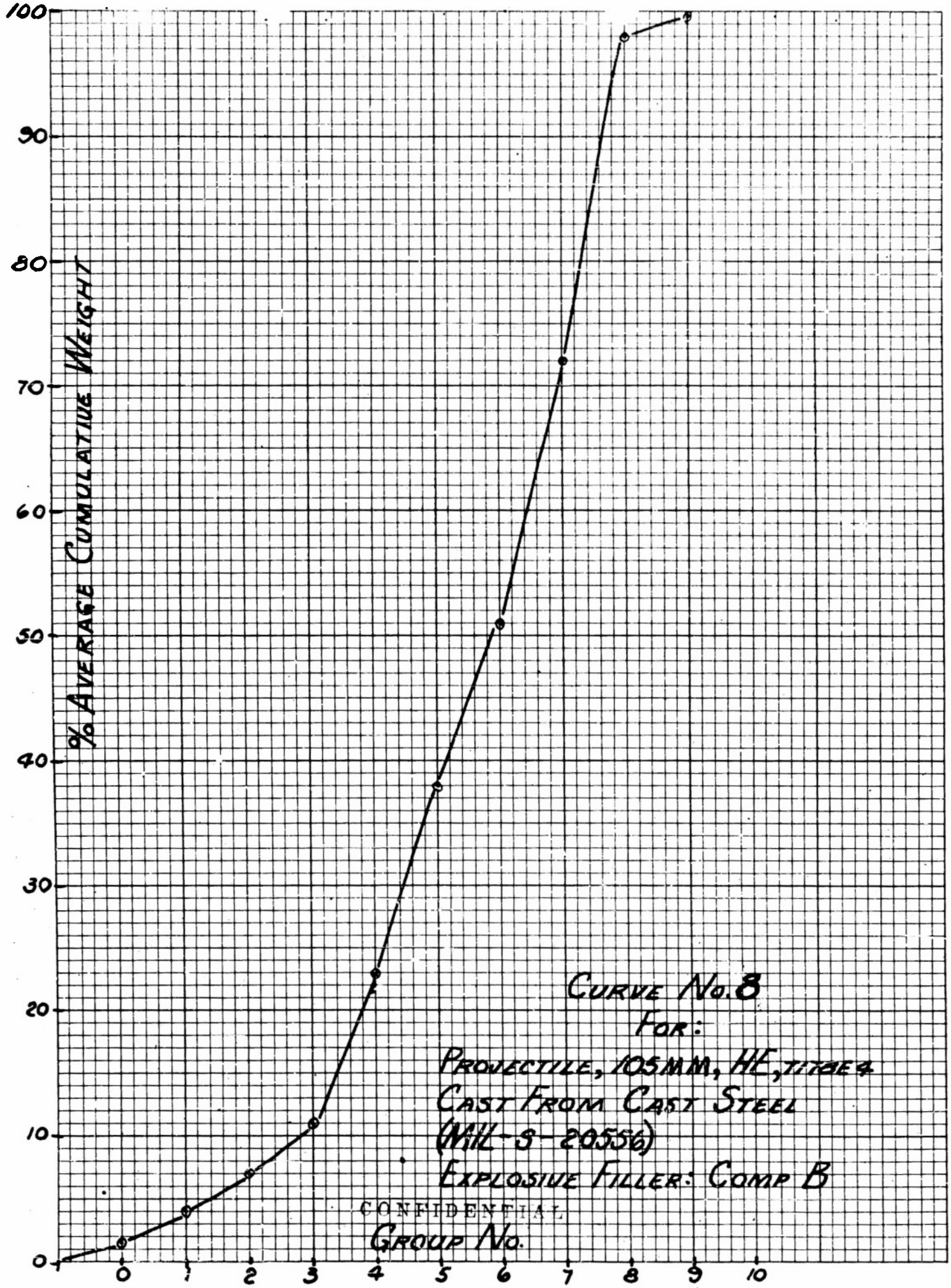
Curve No. 5
For:
Projectile, 105mm, HE, Tiibe I,
Cast From Class 30 Cast Iron
(QQ-I-652)
Explosive Filler: Comp B

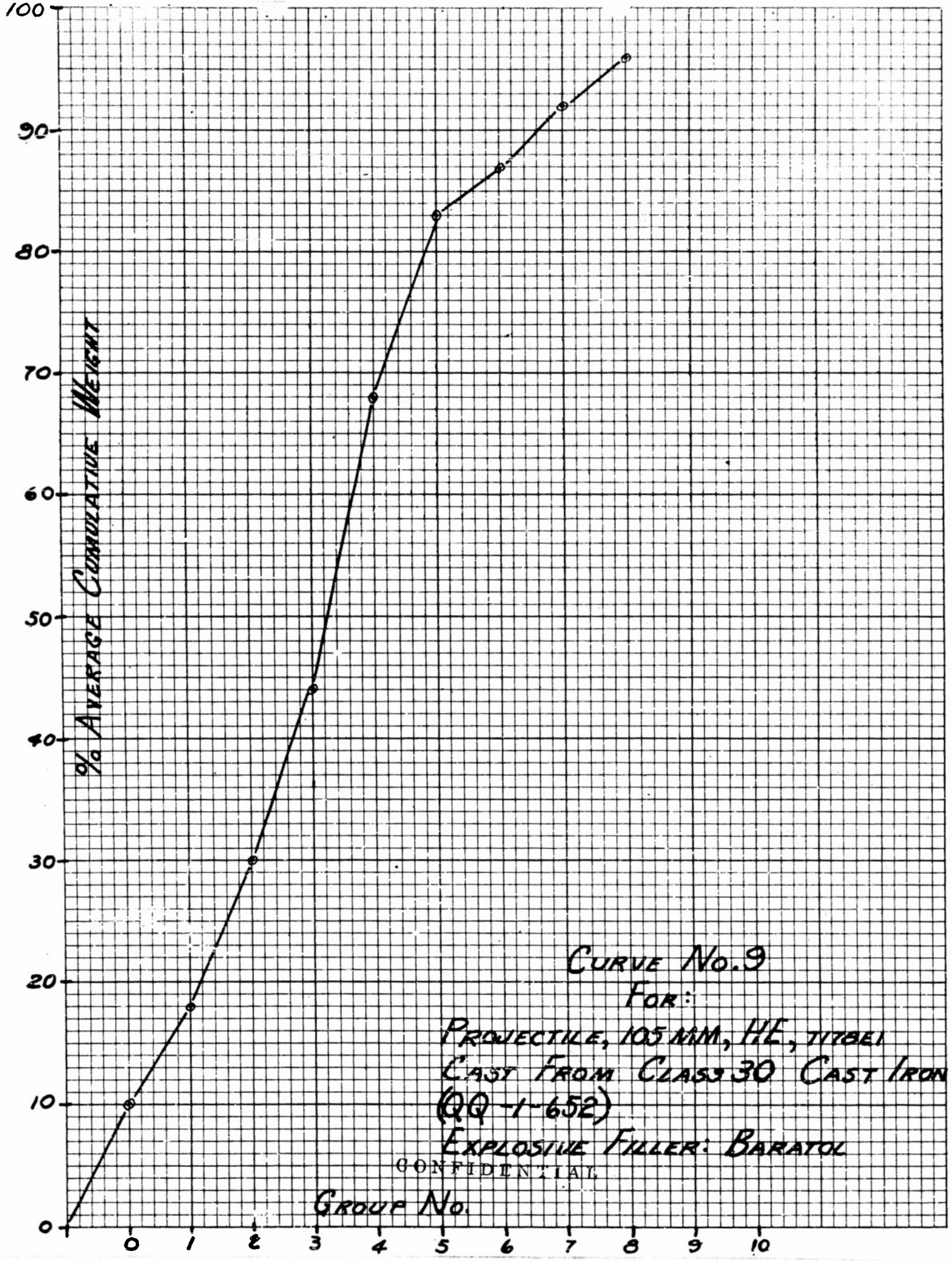


Curve No. 6.
For:
Projectile, 105MM, HE, Tiltle 2,
Cast From Class 50 Cast Iron
(QQ-I-652)
Explosive Filler: Comp B



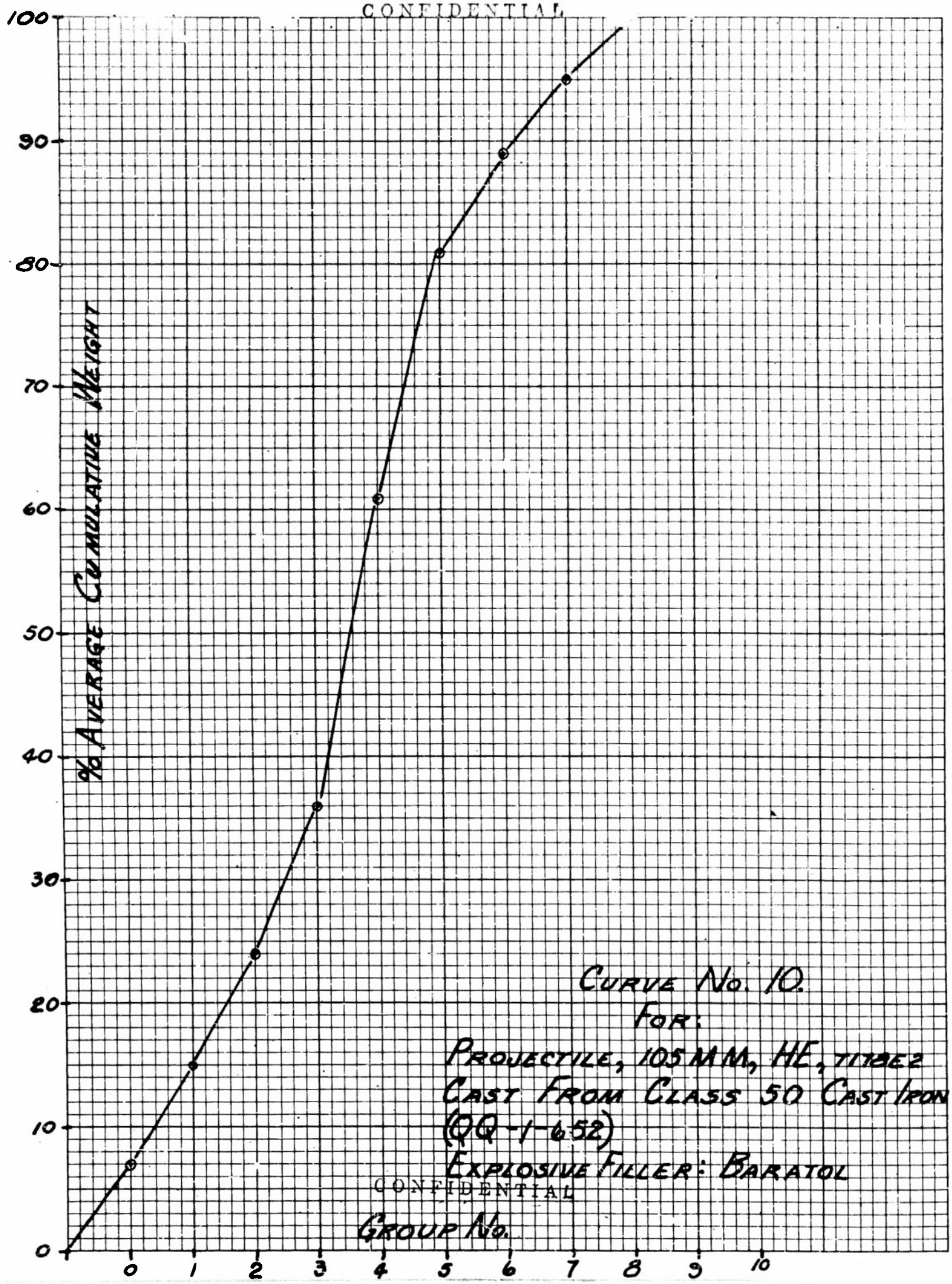
CONFIDENTIAL


% Average Cumulative Weight
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Group No.
Curve No. 8
For:
Projectile, 105MM, HE, Type 4
Cast From Cast Steel
(Mil-S-20556)
Explosive Filler: Comp B



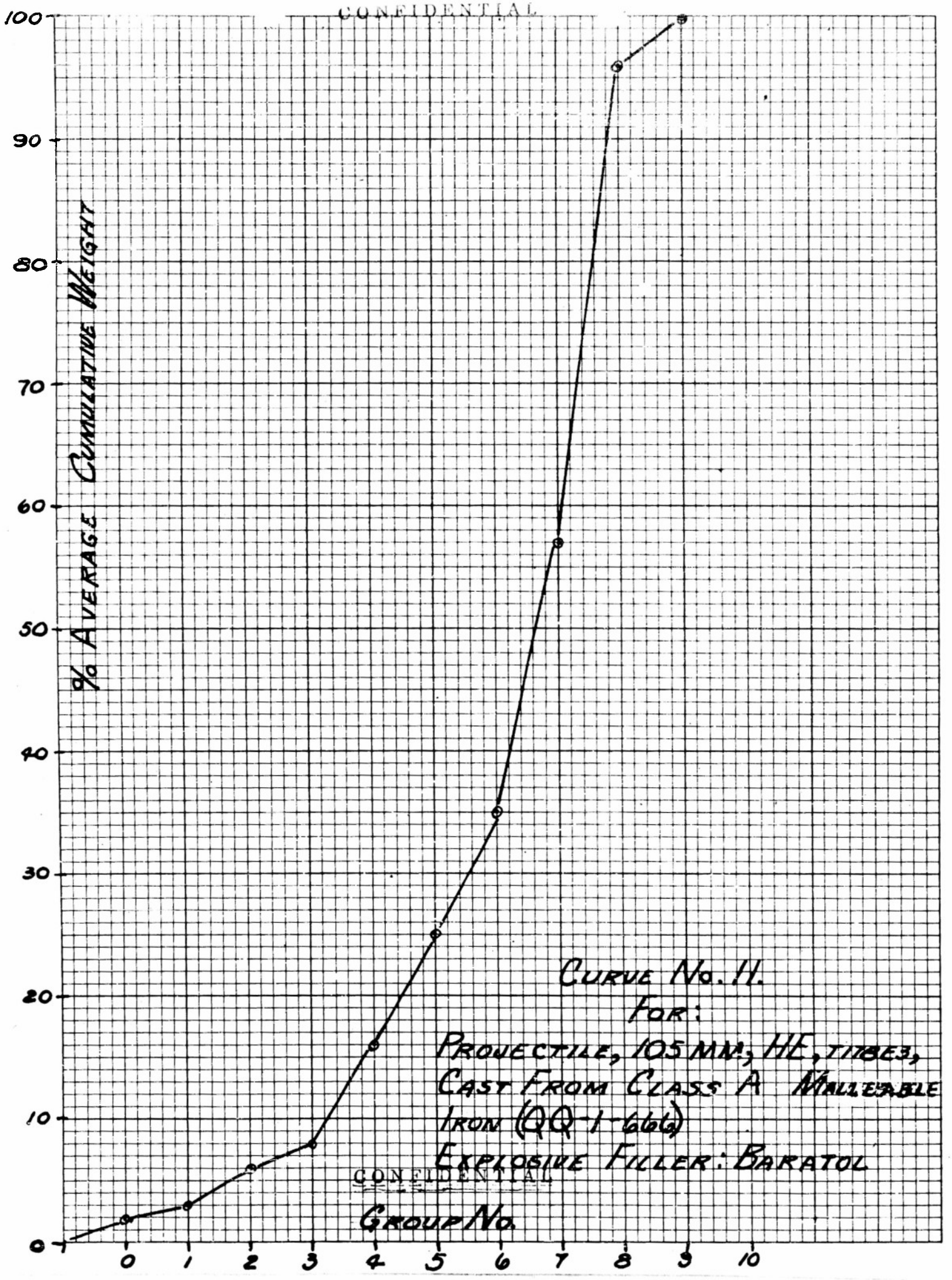
Curve No. 9
For:
Projectile, 105 MM, HE, M1B1
Cast From Class 30 Cast Iron
(QQ-I-652)
Explosive Filler: Baratol

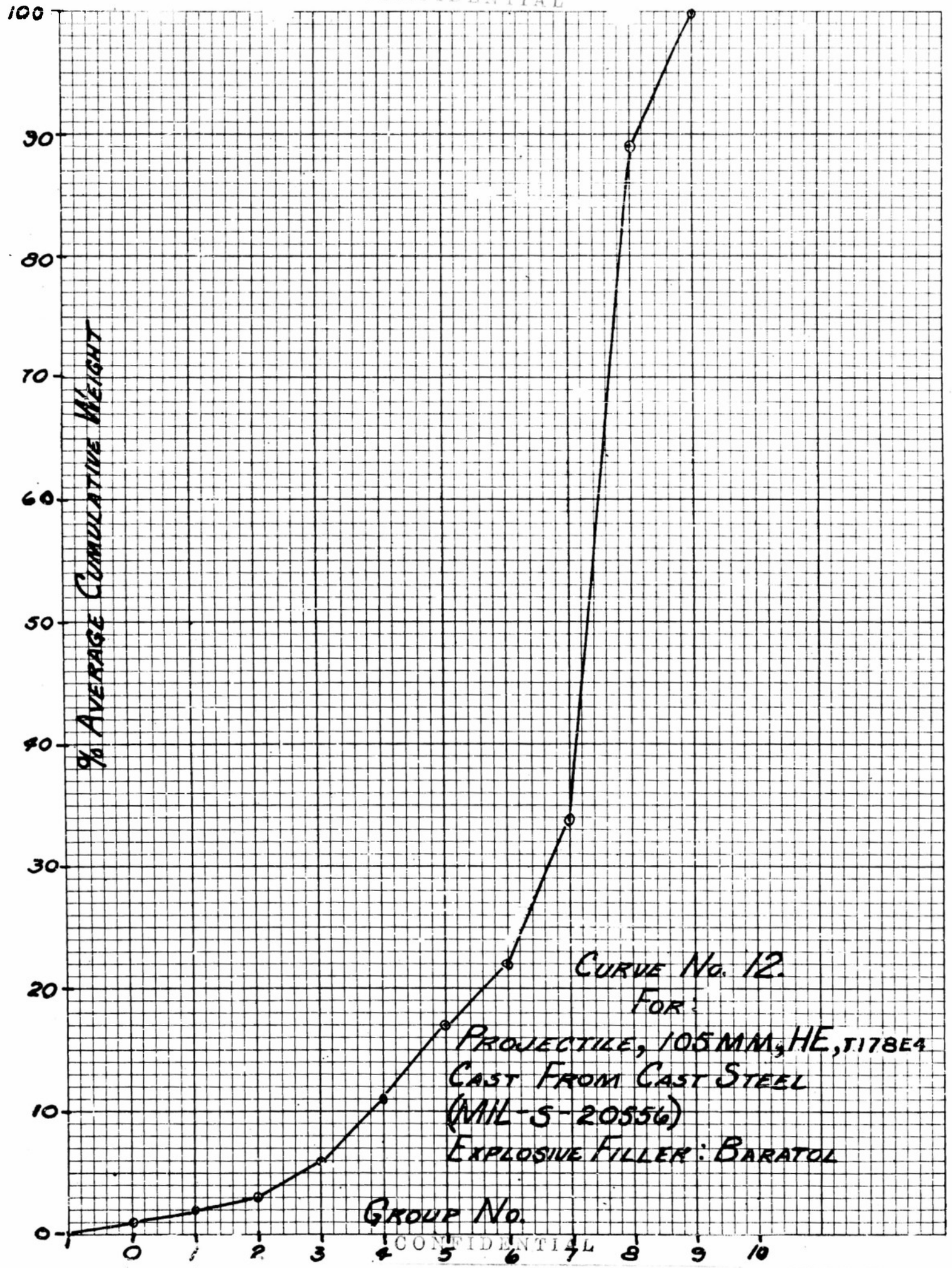
CONFIDENTIAL

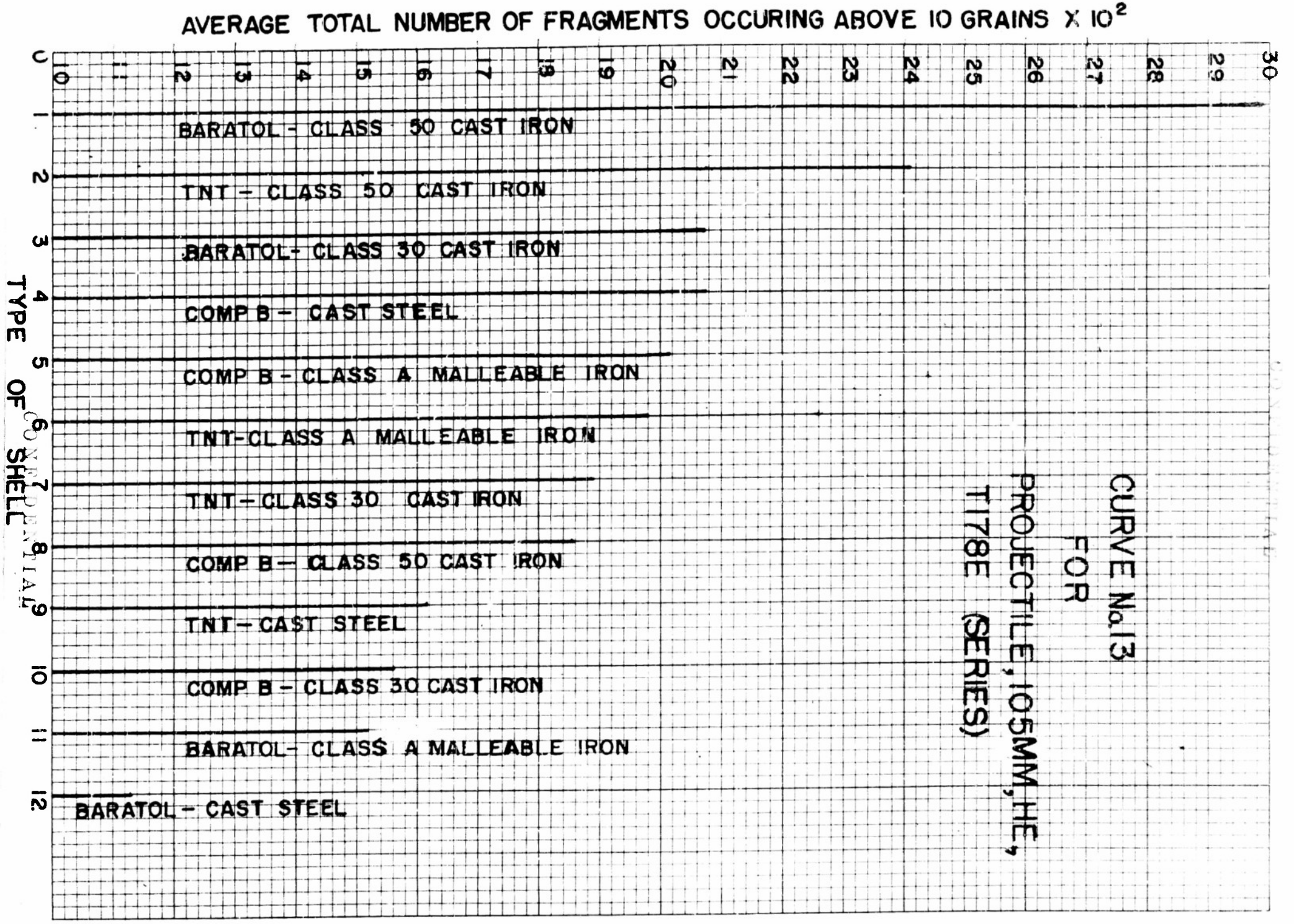


Curve No. 10.
For:
Projectile, 105 MM, HE, T178E2
Cast From Class 50 Cast Iron
(QQ-I-652)
Explosive Filler: Baratol

CONFIDENTIAL


% Average Cumulative Weight
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Group No.
Curve No. H.
For:
Projectile, 105 MM; HE, Time3,
Cast From Class A Malleable
Iron (QQ-I-666)
Explosive Filler: Baratol


100
90
80
70
60
50
40
30
20
10
0
% Average Cumulative Weight
0
1
2
3
4
5
6
7
8
9
10
Group No.
Curve No. 12.
For:
Projectile, 105MM, HE, T178E4
Cast From Cast Steel
(MIL-S-20556)
Explosive Filler: Baratol

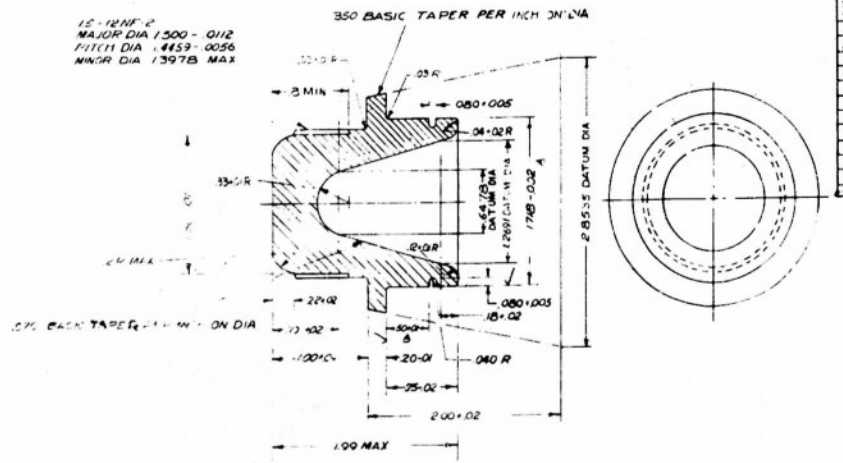

AVERAGE TOTAL NUMBER OF FRAGMENTS OCCURING ABOVE 10 GRAINS X 10²
0 -- 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
TYPE OF SHELL
1 BARATOL - CLASS 50 CAST IRON
2 TNT - CLASS 50 CAST IRON
3 BARATOL - CLASS 30 CAST IRON
4 COMP B - CAST STEEL
5 COMP B - CLASS A MALLEABLE IRON
6 TNT - CLASS A MALLEABLE IRON
7 TNT - CLASS 30 CAST IRON
8 COMP B - CLASS 50 CAST IRON
9 TNT - CAST STEEL
10 COMP B - CLASS 30 CAST IRON
11 BARATOL - CLASS A MALLEABLE IRON
12 BARATOL - CAST STEEL
CURVE No. 13
FOR
PROJECTILE, 105MM, HE,
T178E (SERIES)

LIST OF PARTS

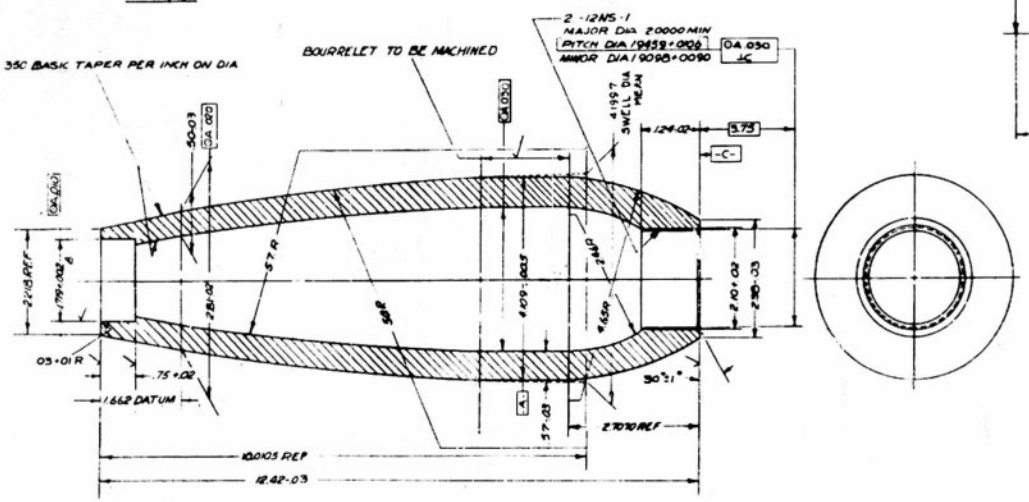
LINE NO	NAME OF PART	NUMBER REQD PER COMPONENT	PIECE MARK	MATERIAL: SIZE OR FORM	MATERIAL: KIND	MATERIAL: GRADE	MATERIAL: SPEC NUMBER	APPROX WEIGHT EACH		REMARKS
1	SHELL, BODY (T178E1)	1		CAST	CAST IRON	CLASS 30	QQ-I-652	16.91		
2	SHELL, BODY (T178E2)	1		CAST	CAST IRON	CLASS 50	QQ-I-652	16.91		
3	SHELL, BODY (T178E3)	1		CAST	MALLEABLE IRON	CLASS A	QQ-I-666	16.91		
4	SHELL, BODY (T178E4)	1		CAST	STEEL		MIL-S-2008	16.91		
5	SHELL, BODY (T178E5)	1		CAST	DUCTILE IRON	CLASS 5	MIL-I-4461	16.91		
6	SHELL, BODY (T178E6)	1		CAST	DUCTILE IRON	CLASS 4	MIL-I-4461	16.91		
7	PLUG	1		CAST	SAME MATERIAL AS SHELL BODY			.79		
8					SEALING WIRE	CLASS 4	QQ-S-561			
9					FLUX, BRAZING		4-1121			
10					BRAZING ALLOY (AS REQUIRED) BAg-2		MIL-E-1044			
11					PAINT, ACID RESIST, BLACK	TYPE I OR II	TT-P-29			
12	SHELL, BODY (T178E7)	1		CAST	DUCTILE IRON	CLASS 2	MIL-I-4461	16.91		

(A) THESE DIMENSIONS MAY BE VARIED TO EFFECT AN OPTIMUM SILVER SOLDERED JOINT.

1. PREPARE OR CLEAN ALL INTERIOR SURFACES OF SHELL IN ACCORDANCE WITH GRADE I OR II (TYPE OPTIONAL) SPEC MIL-C-10-41 BEFORE PAINTING.
2. PREPARE ALL EXTERIOR SURFACES OF SHELL IN ACCORDANCE WITH GRADE I SPEC MIL-C-10-41 BEFORE PAINTING.
3. COAT ENTIRE INTERIOR SURFACES OF SHELL, INCLUDING THREADS, WITH ACID RESIST BLACK PAINT, TYPE I OR II.
4. COAT EXTERIOR SURFACE OF SHELL, EXCEPT THREADS, WITH GREEN (CLASSIFIED) 34-2 ENAMEL.
5. PRESENCE, SHAPE AND LOCATION OF SOLDER GROOVE OPTIONAL.
6. OUTSIDE DIAMETER OF BODY MUST BE FLUSH TO OR LARGER THAN PLUG.
7. 360° SILVER BRAZE, HAND BRAZING PERMISSIBLE. USE SAME BRAZING ALLOY AS SPECIFIED IN NOTE 1. AFTER BRAZING REMOVE FLUX AND OXIDES FROM INTERIOR AND EXTERIOR SURFACES. EXTERIOR MUST BE CLEAN TO ORIGINAL CONTOUR.
8. STAMP LOT NUMBER, YEAR OF MANUFACTURE, CALIBER AND DESIGNATION OF SHELL, ONE INCH FROM PLUG SHOULDER TO BOTTOM OF LETTERS. LETTERS AND FIGURES .125 HIGH BY .01 DEEP.
9. ASSEMBLY BEFORE PAINTING, SHALL WITHSTAND A HYDROSTATIC PRESSURE TEST OF 10,000 PSI MIN FOR 15 SECONDS MIN. STAMP LETTER H AFTER ACCEPTANCE. LETTER .125" HIGH BY .01 DEEP AND 3.5 INCHES FROM PLUG SHOULDER TO BOTTOM OF LETTER.
10. ASSEMBLY BEFORE PAINTING, SHALL WITHSTAND AN INTERNAL AIR PRESSURE TEST OF 150 PSI MIN FOR 15 SECONDS MIN AFTER HYDROSTATIC PRESSURE TEST. STAMP LETTER A AFTER ACCEPTANCE AND AFTER H OF NOTE 9.

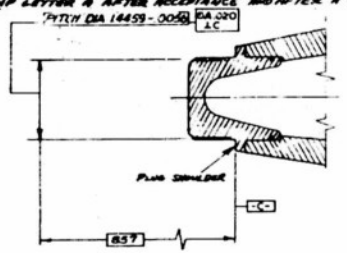


PLUG



BODY, SHELL, T178E1 ET AL

SURFACE MARKED / TO HAVE 125/



METAL PARTS ASSEMBLY

SCALE 1/1

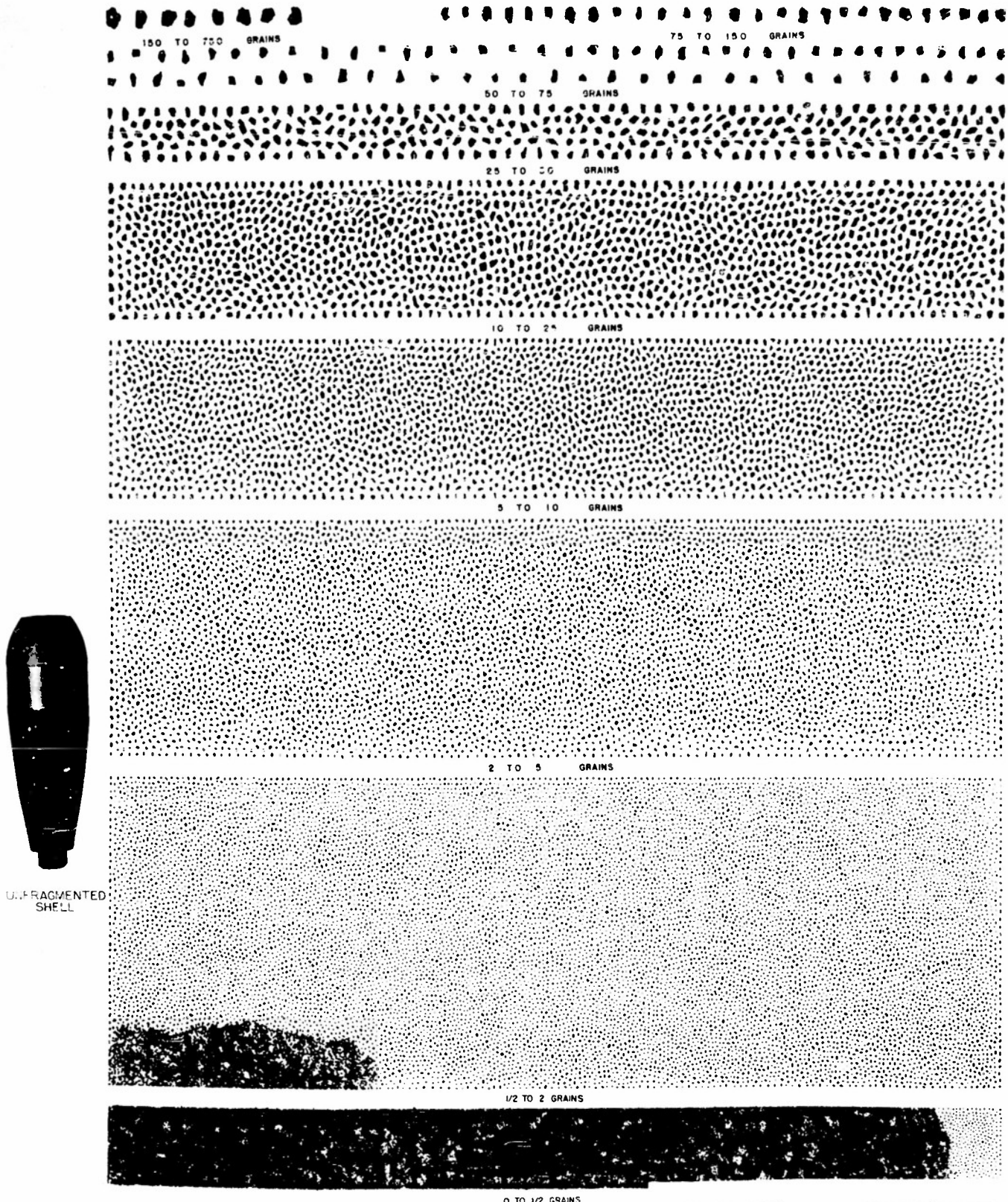
DESIGN STUDY

SHELL, HE, 105MM, T178E1 ET AL

ORDNANCE DEPT DEPT OF THE ARMY

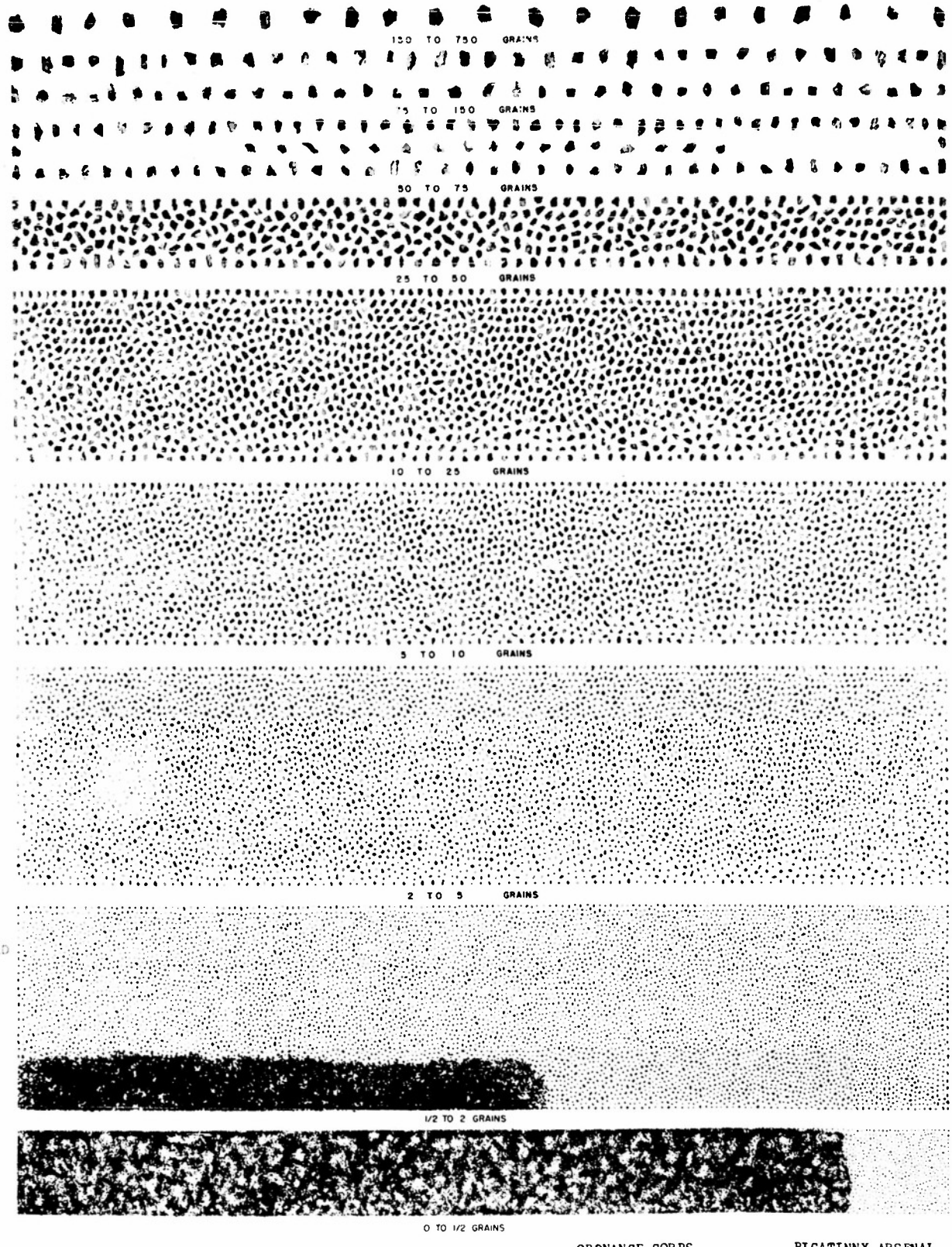
F

P-62283



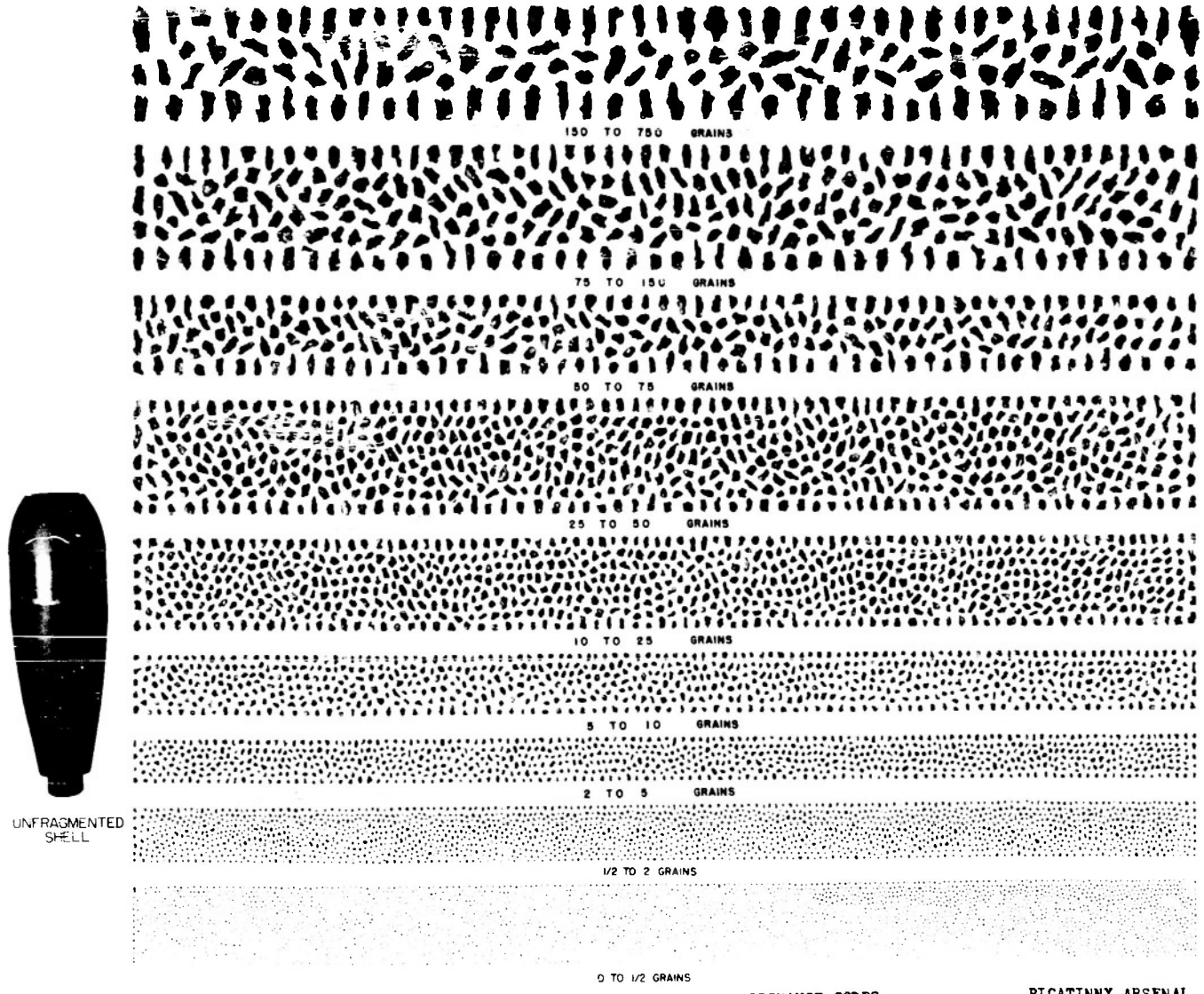
UNFRAGMENTED SHELL

ORDNANCE CORPS PICATINNY ARSENAL
SHELL,HE,105MM,T178E1 CLASS 30 CAST IRON
TNT LOADED QQ-I-652
MFGD. BY LEHIGH FOUNDRIES,INC. EASTON,PA
SHELL NO. 1 MARCH 1954 M-41485

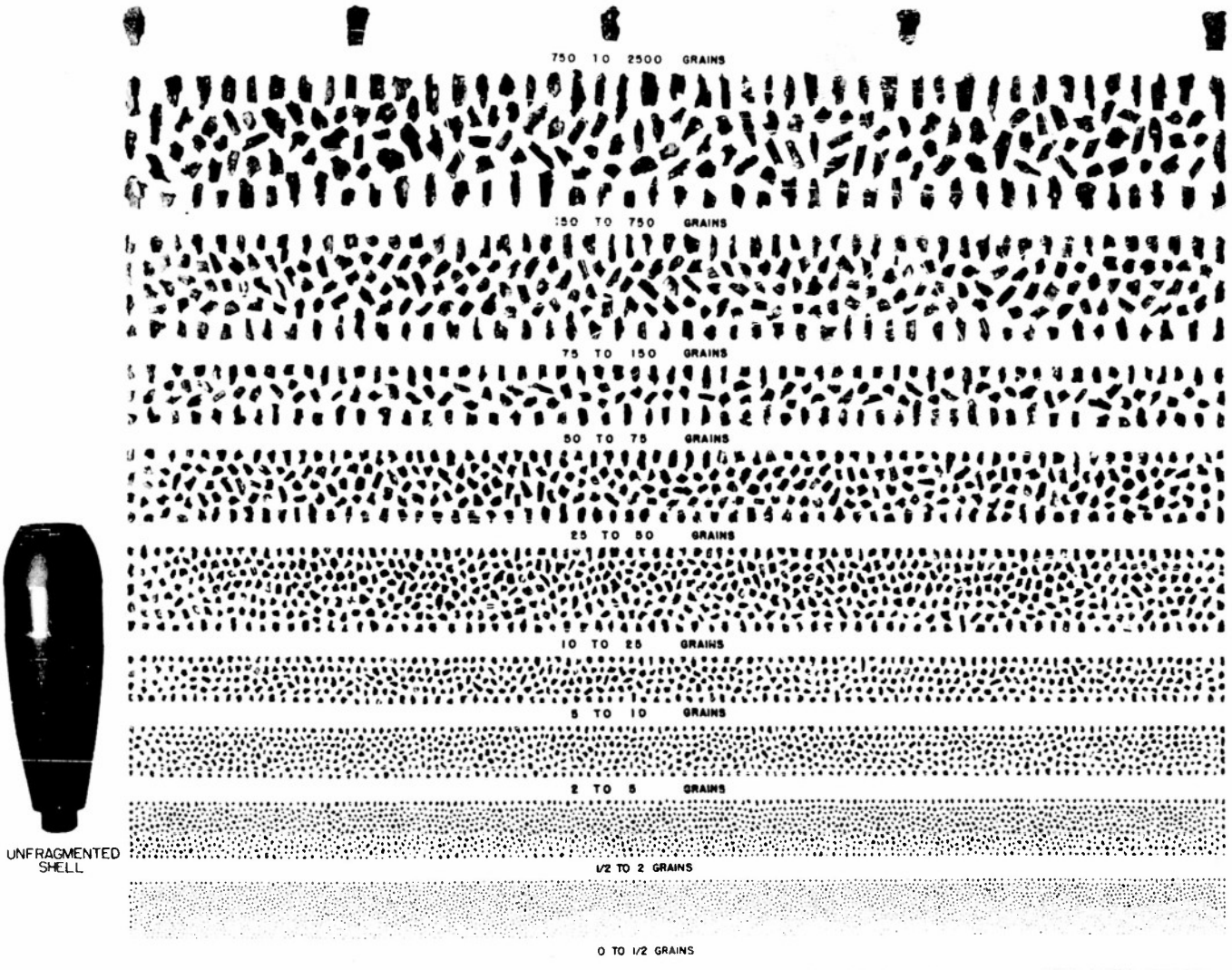


UNFRAGMENTED SHELL

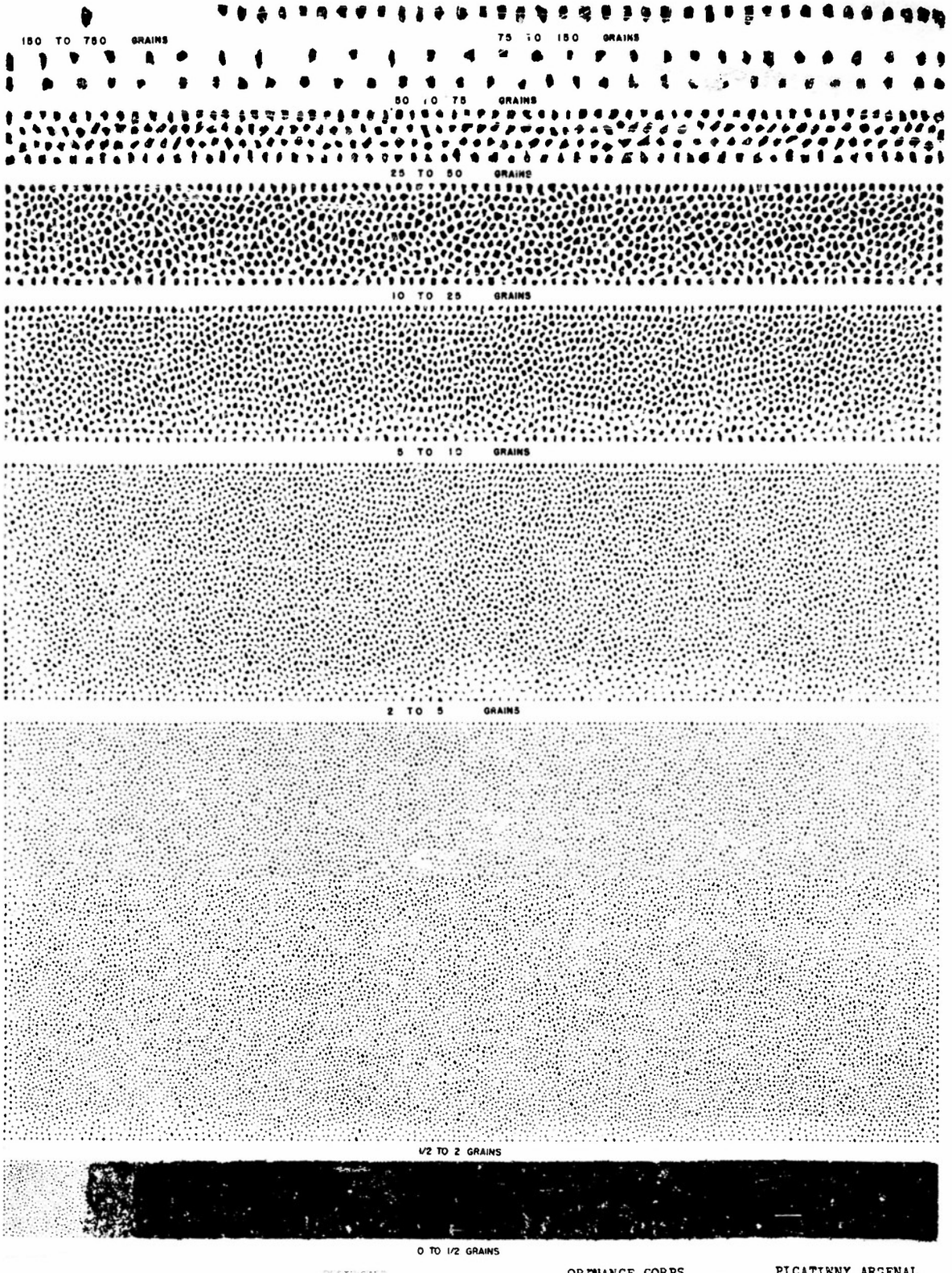
ORDNANCE CORPS PICATINNY ARSENAL
SHELL,HE,105MM,T178E2 CLASS 50 CAST IRON
TNT LOADED QQ-I-652
MFGD.BY LEHIGH FOUNDRIES,INC.EASTON,PA
SHELL NO. 3 MARCH 1954 M-41487



ORDNANCE CORPS PICATINNY ARSENAL
SHELL, HE, 105MM, T178E3 CLASS A MALLEABLE IRON
TNT LOADED QQ-I-666
MFGD. BY LEHIGH FOUNDRIES, INC. EASTON, PA
SHELL NO. 5 DECEMBER 1953 M-41489



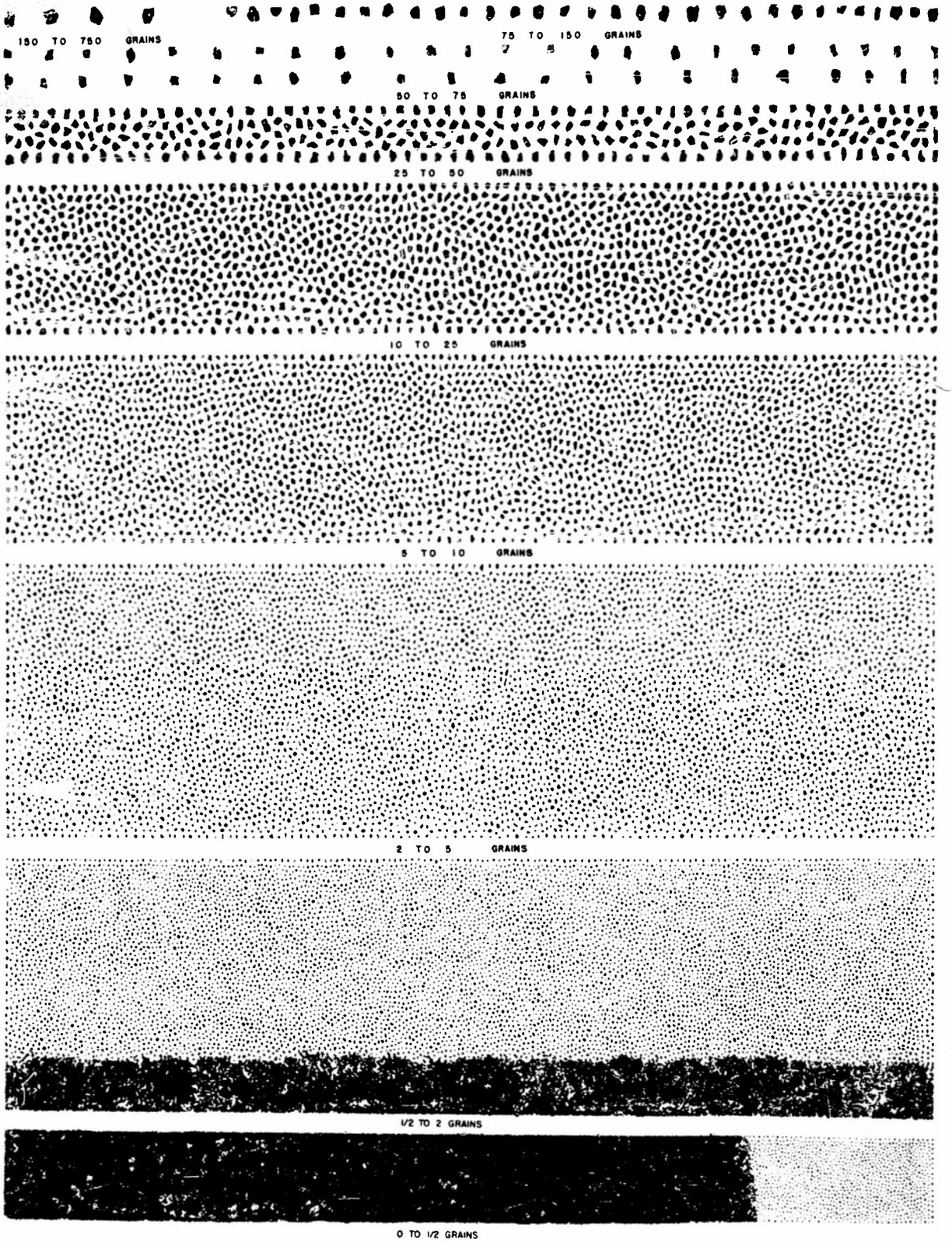
ORDNANCE CORPS PICATINNY ARSENAL
SHELL, HE, 105MM, T176E4 CAST STEEL
TNT LOADED MIL-S-20556
MFGD. BY LEHIGH FOUNDRIES, INC. EASTON, PA
SHELL NO. 7 DECEMBER 1953 M-41491



UNFRAGMENTED SHELL

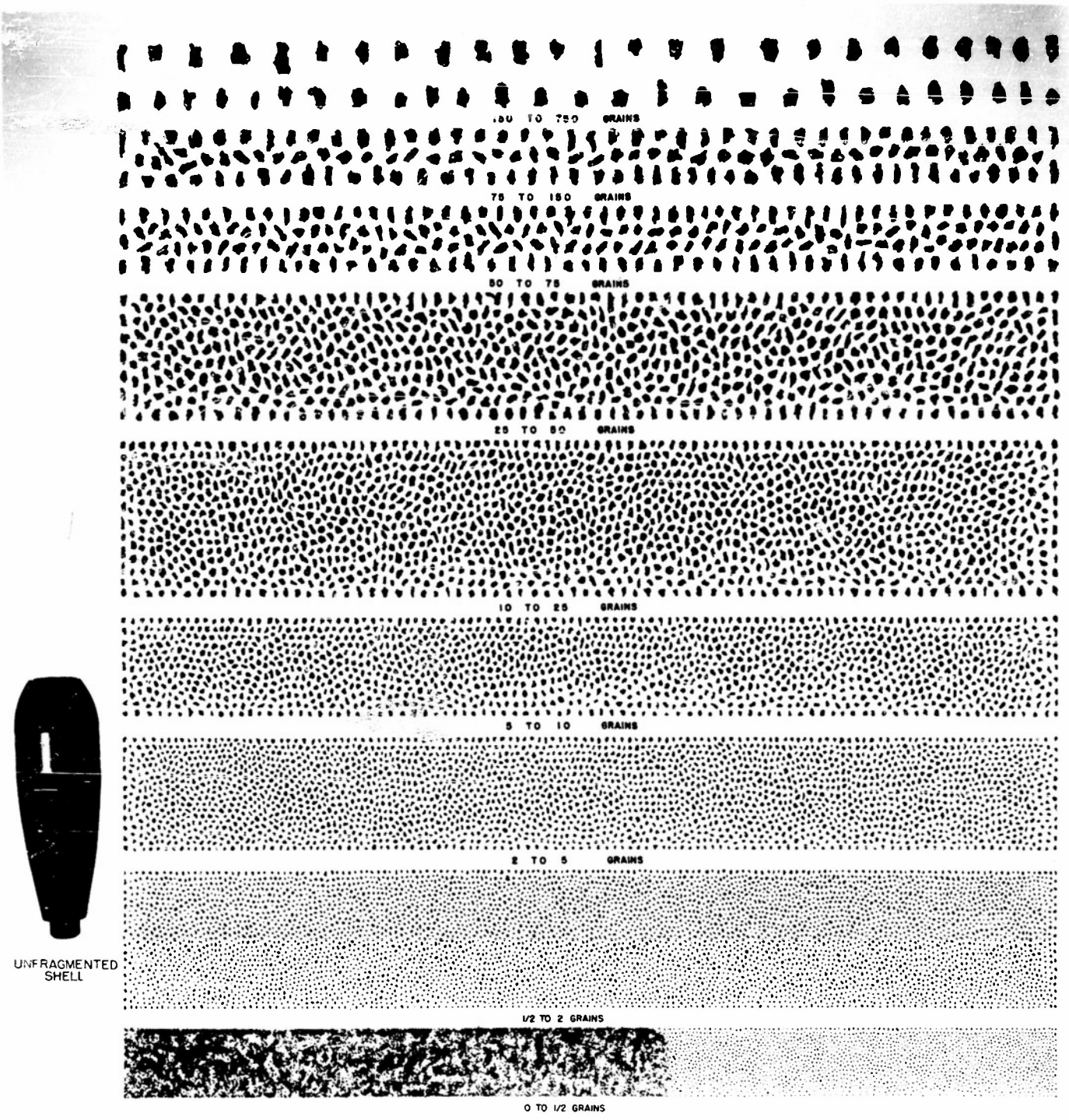
RESTRICTED

ORDNANCE CORPS PICATINNY ARSENAL
SHELL, HE, 105MM, T178E1 CLASS 30 CAST IRON
COMP. B LOADED QQ-I-652
MFGD. BY LEHIGH FOUNDRIES, INC. EASTON, PA
SHELL NO. 9 DECEMBER 1953 M-42034

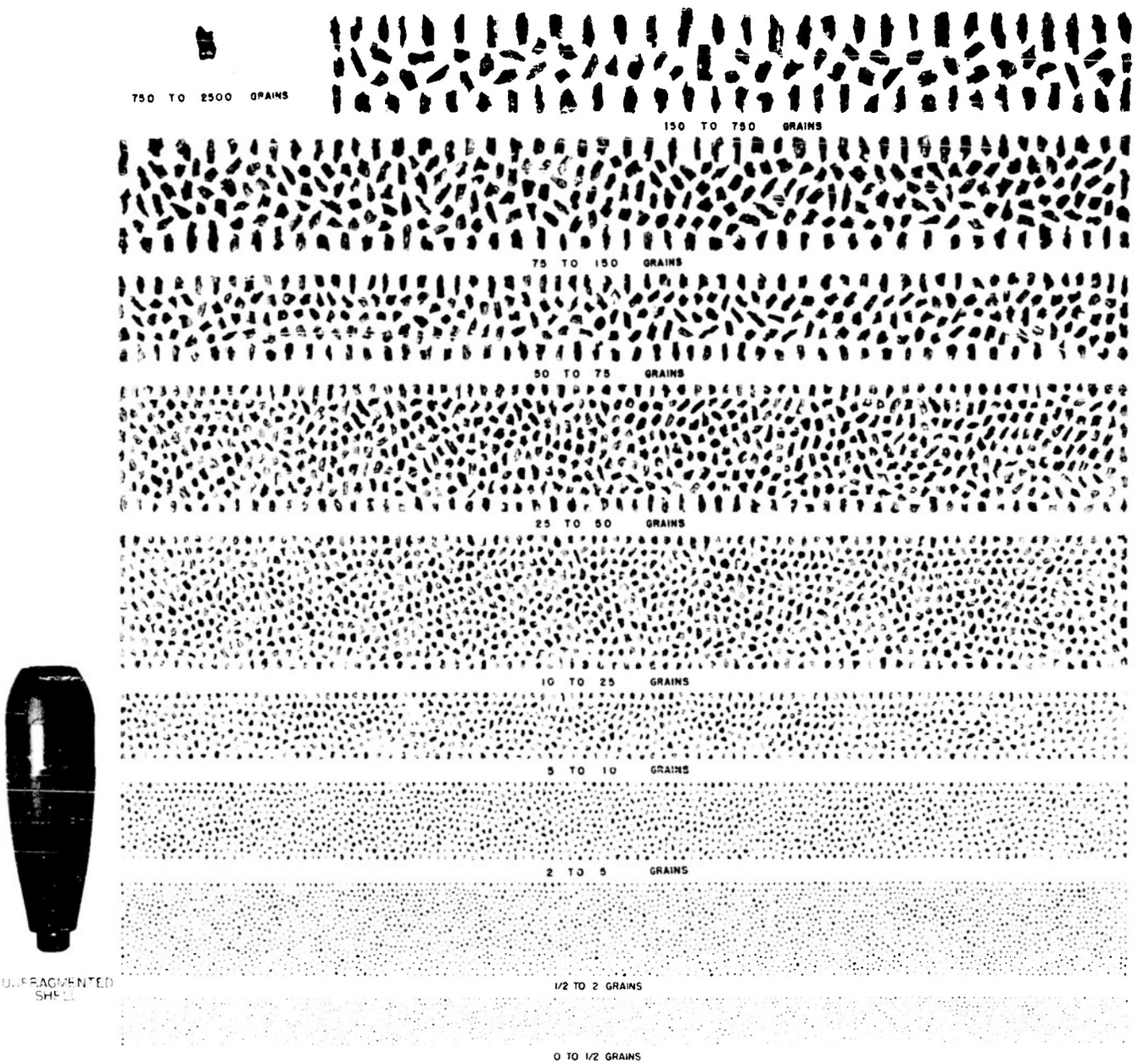


FRAGMENTED SHELL

ORDNANCE CORPS PICATINNY ARSENAL
SHELL, HE, 105MM, T178E2 CLASS 50 CAST IRON
COMP. B LOADED QQ-I-652
MFGD. BY LEHIGH FOUNDRIES, INC. EASTON, PA
SHELL NO. 11 MARCH 1954 M-42036

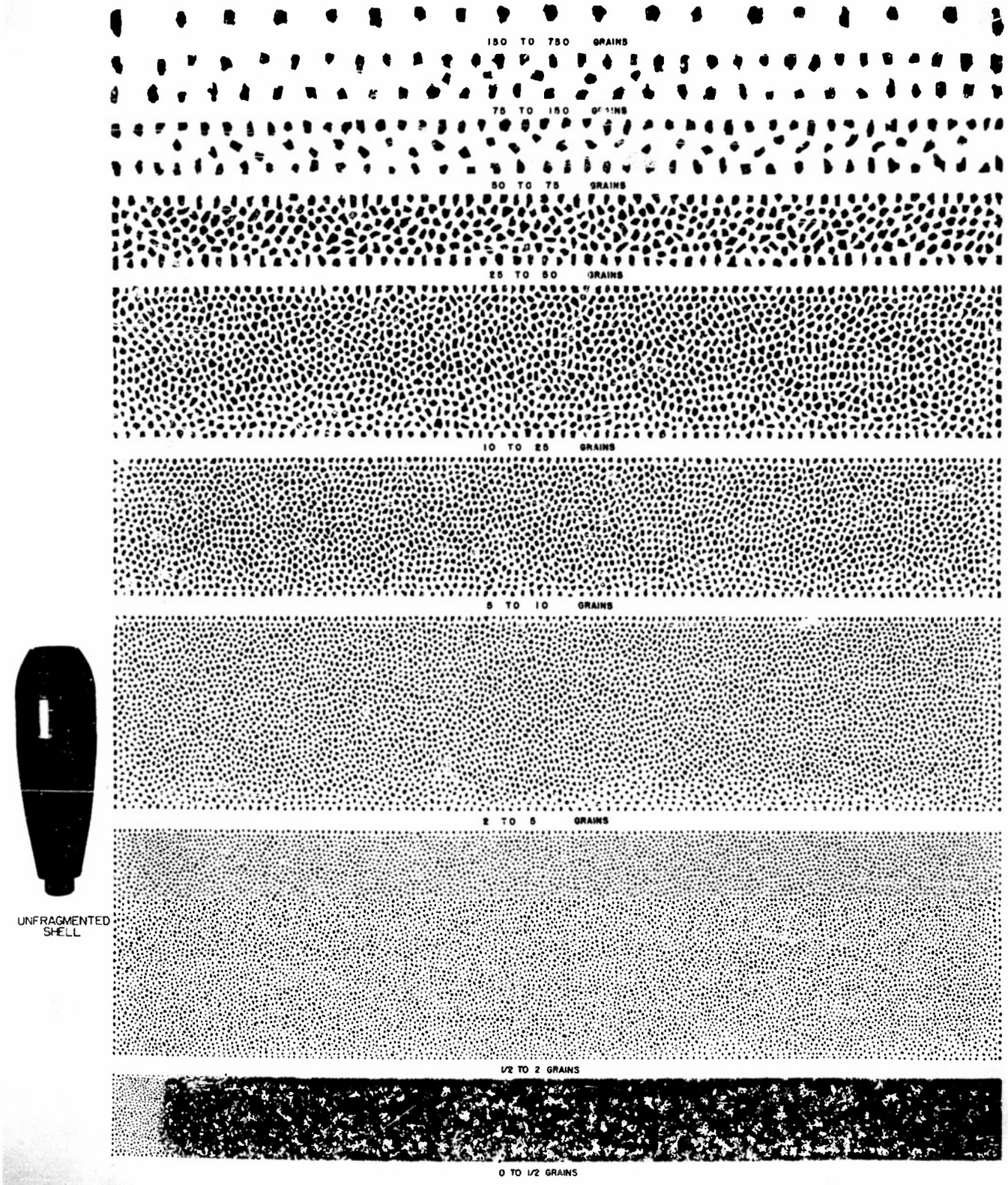


ORDNANCE CORPS PICATINNY ARSENAL
SHELL, HE, 105MM, T178E3 CLASS A MALLEABLE IRON
COMP. B LOADED QQ-I-666
MFGD. BY LEHIGH FOUNDRIES, INC. EASTON, PA
SHELL NO. 13 MARCH 1954 M-42038

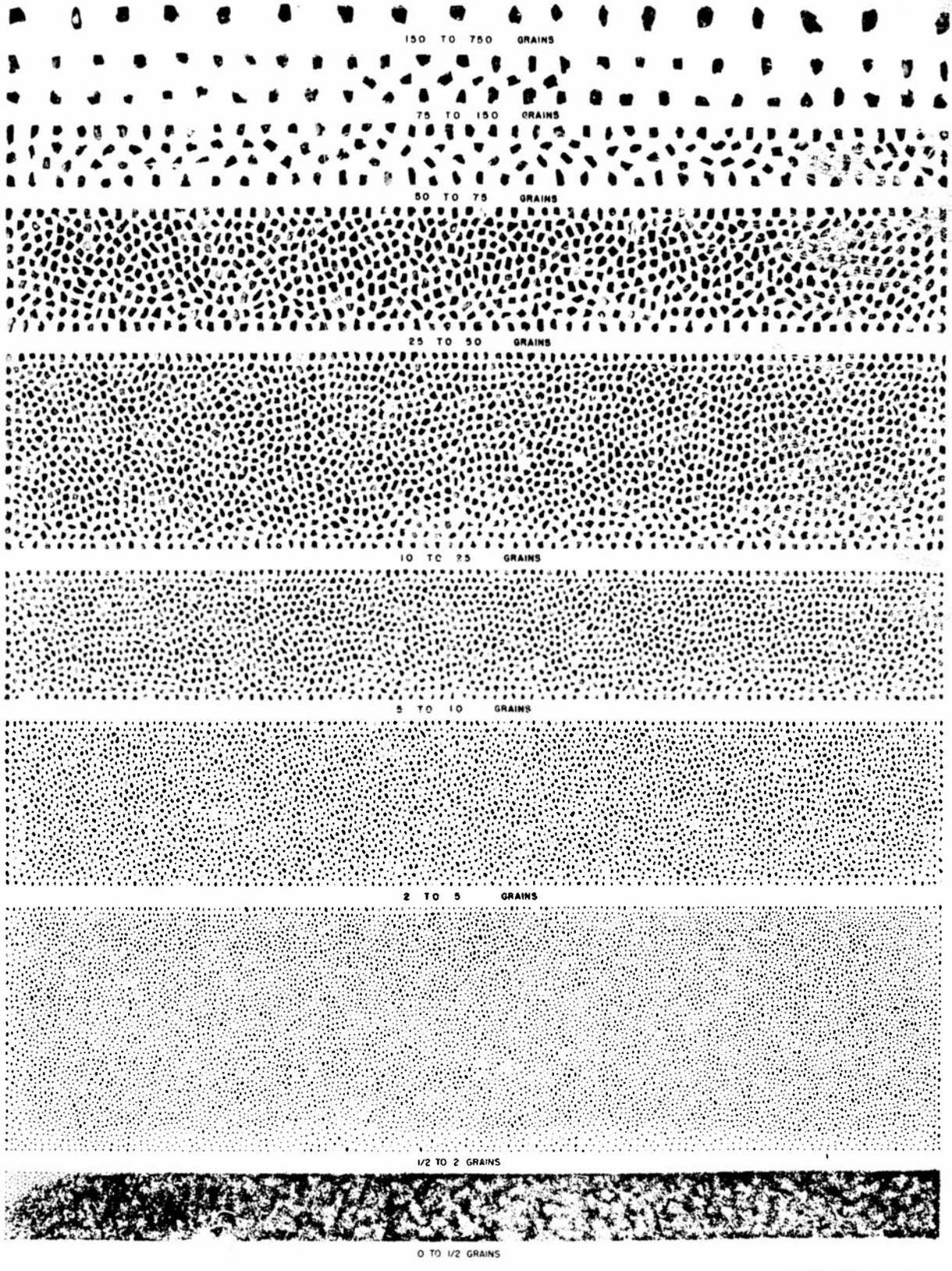


U. FRAGMENTED SHELL

ORDNANCE CORPS PICATINNY ARSENAL
SHELL,HE,105MM,T178E4 CAST STEEL
COMP.B LOADED MIL-S-20556
MFGD.BY LEHIGH FOUNDRIES,INC.EASTON,PA
SHELL NO. 15 MARCH 1954 M-42040

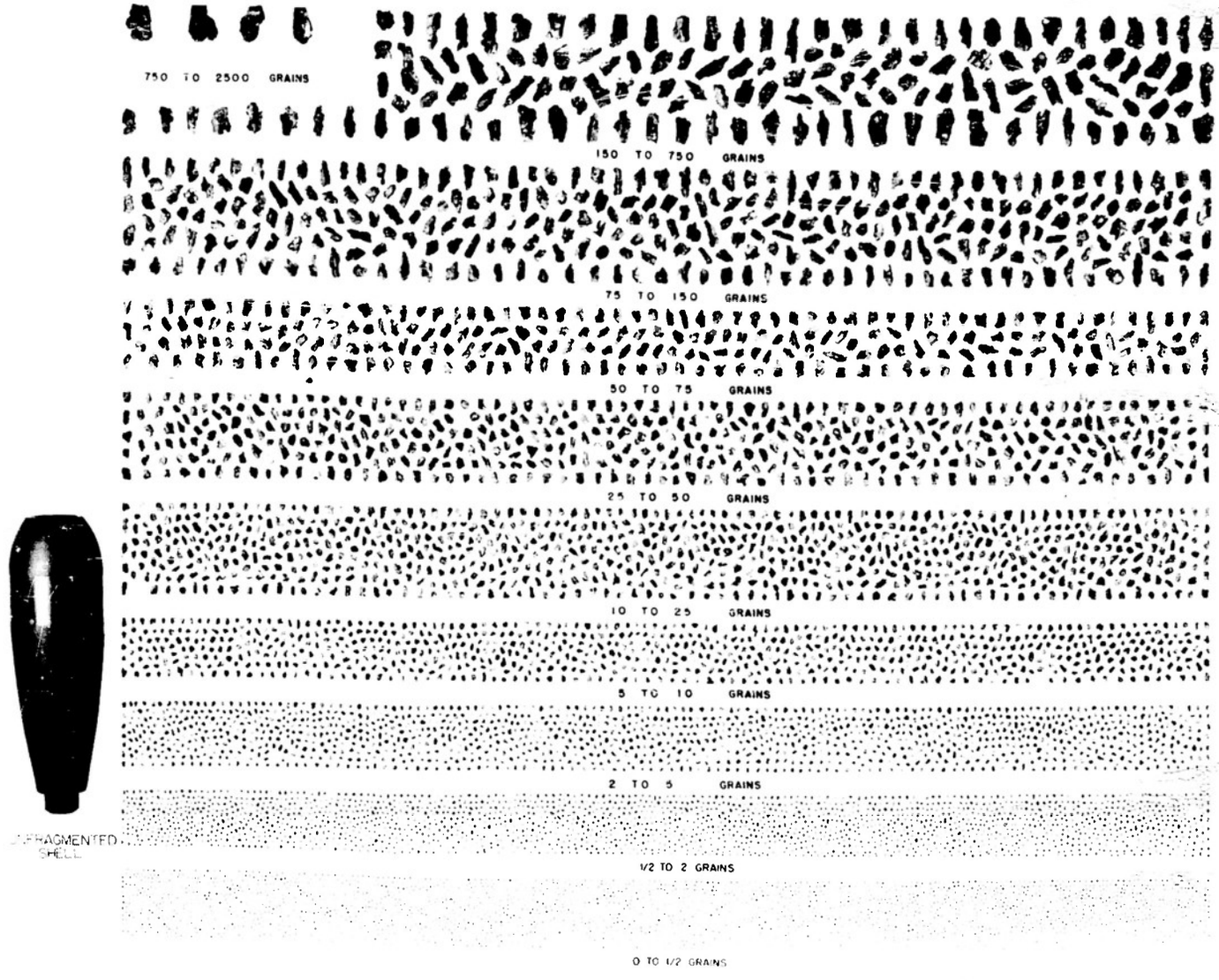


ORDNANCE CORPS PICATINNY ARSENAL
SHELL, HE, 105MM, T178E1 CLASS 30 CAST IRON
70/30 BARATOL LOADED QQ-I-652
MFGD. BY LEHIGH FOUNDRIES, INC. EASTON, PA
SHELL NO. 17 NOVEMBER, 1953 M-42865

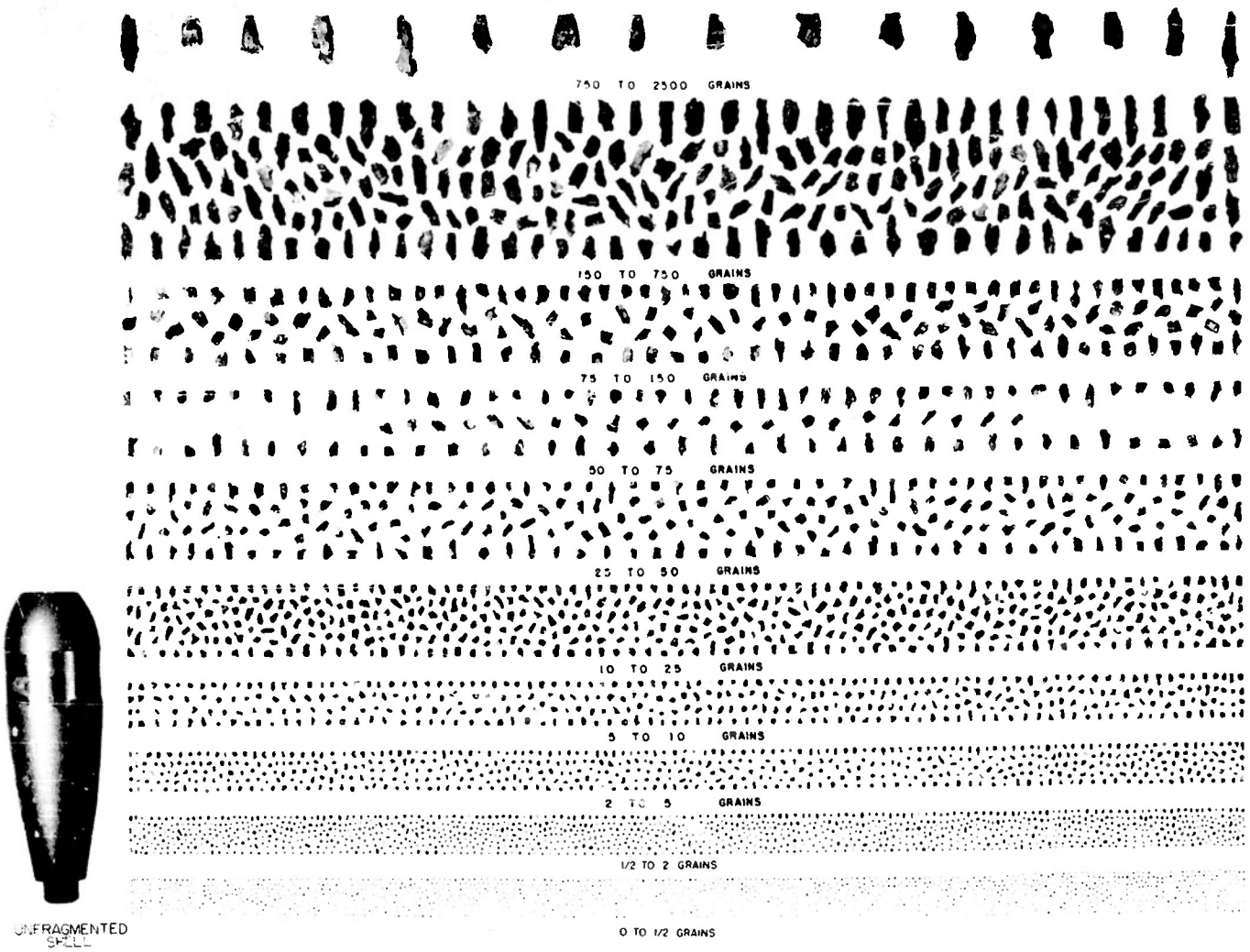


FRAGMENTED SHELL

ORDNANCE CORPS PICATINNY ARSENAL
SHELL,HE,105MM,T178E2 CLASS 50 CAST IRON
70/30 BARATOL LOADED QQ-I-652
MFGD BY LEHIGH FOUNDRIES,INC.EASTON,PA
SHELL NO. 19 NOVEMBER,1953 M-42867



ORDNANCE CORPS PICATINNY ARSENAL
SHELL,HE,105MM,T178E3 CLASS A MALLEABLE IRON
70/30 BARATOL LOADED QQ-I-666
MFGD. BY LEHIGH FOUNDRIES,INC. EASTON,PA
SHELL NO.21 OCTOBER,1953 M-42869



ORDNANCE CORPS PICATINNY ARSENAL
SHELL,HE,105MM,T178E4 CAST STEEL
70/30 BARATOL LOADED MIL-S-20556
MFCD. BY LEHIGH FOUNDRIES INC.,
EASTON,PA
SHELL NO. 23 OCTOBER 1953 M-42871